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Old Firm Erects Modern Foundry

Built to Cope with the Company's Expanding Punch and Shear Business, This Plant Now Handles Overflow Machine Tool Casting Business of the Vicinity

UNPRECEDENTED demand for plates and structural steel shapes during the past few years, while primarily affecting the mills also has been reflected in the machine tool industry, especially among plants making those tools employed in the yards and shops where this material is fabricated.

Punches, shears, single and multiple drills, bending and straightening rolls, presses, hot and cold saws, bulldozers and other forms of mechanical equipment while made in ever increasing quantities, have not been supplied to meet the requirements in this particular field. Many orders for these tools emanated from new concerns, but the majority were, and are, from firms expanding plants to handle a larger volume of business. Methods change with the times in steel fabricating, as in every other line of endeavor, and tools and equipment which were considered the last word in efficiency a few years ago, now, in a great many cases are considered fit only for the scrap pile and entered as such on the yearly inventory. A machine capable of punching or drilling one hole at a time was fast enough in the days when a pair of skillful two-handed riveters required 10 hours in which to drive 120 cone-head rivets in the lapped joint of a boiler sheet, but it had no place in a yard where each riveting gang accounted for at least 2000 holes a day as they did in the sides of vessels ordered by the Emergency Fleet corporation.

Rolling stock on the railroads has been growing steadily in size and quantity in recent years and machinery manufacturers have done their best to keep pace with the increased demand for larger and more efficient types of machine tools particularly adapted to that class of work. The same is true in the automobile industry, in building bridges and steel frame buildings and other forms or expressions of

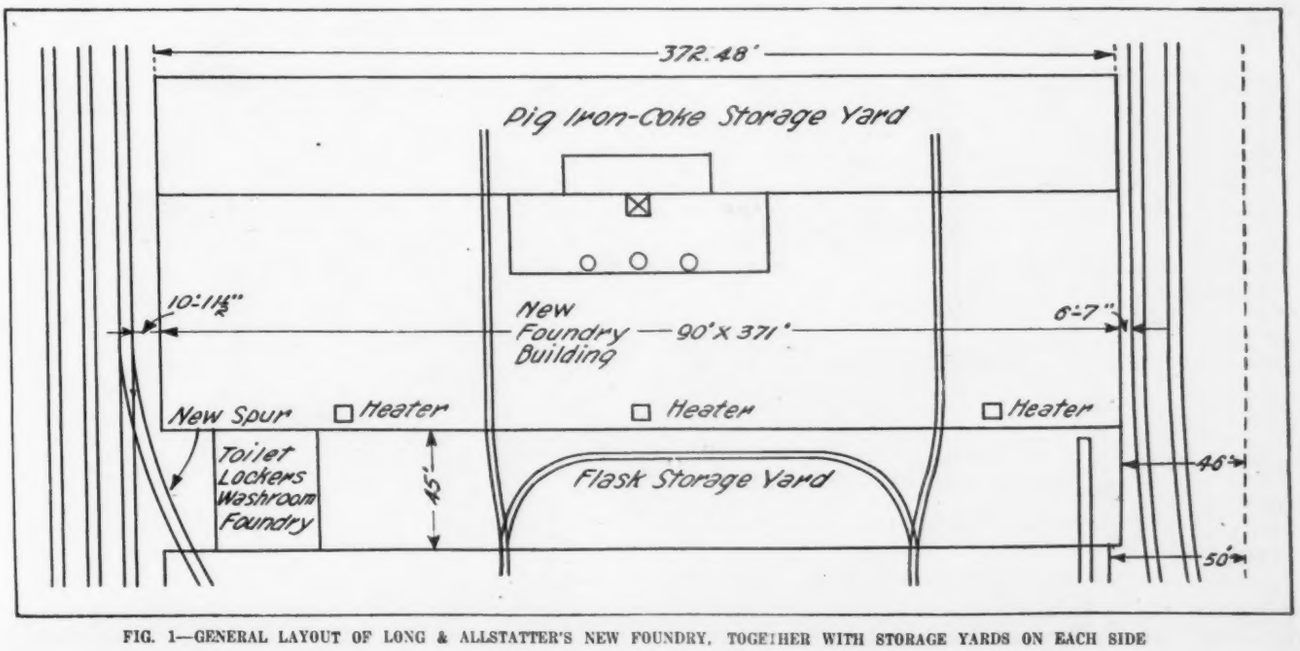


FIG. 1—GENERAL LAYOUT OF LONG & ALLSTATTER'S NEW FOUNDRY, TOGETHER WITH STORAGE YARDS ON EACH SIDE

FIG. 2—GENERAL VIEW OF THE INTERIOR LOOKING WEST—NOTE THE CRANE ON THE LOWER TRACK, THE CLAM SHELL BUCKET AND THE HEATERS

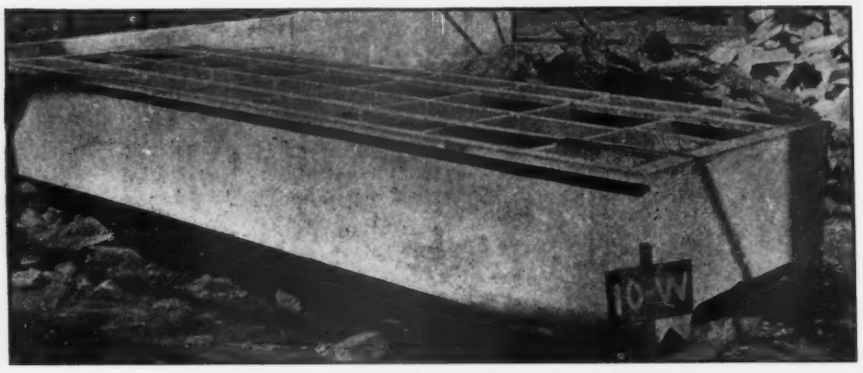


FIG. 3—CASTING FOR OPEN SIDE PLANER BED—IT IS CAST IN THE POSITION SHOWN—CORES TO FORM THE POCKETS FORM AN INTEGRAL PART OF THE COVER CORES

industrial activity based on fabricated metal parts.

Prominent among the firms engaged in this line is the Long & Alstatter Co., Hamilton, O., which recently has completed and placed in operation a strictly modern foundry for the production of a wide and varied line of punches, shears and other machinery employed in fabricating plates and shapes. The plan, Fig. 1, indicates that the shops of this company are situated between the Baltimore and Ohio railroad on one side and the Pennsylvania railroad on the other and that

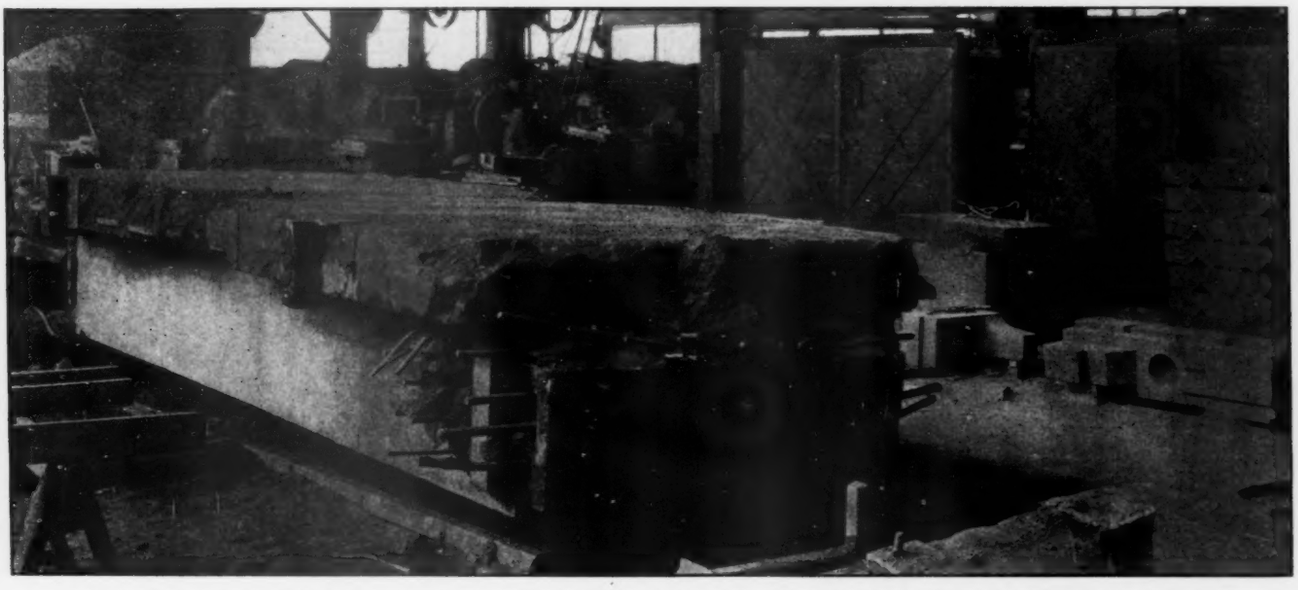


FIG. 4—SAME CASTING SHOWN IN FIG. 3 JUST AFTER COMING OUT OF THE SAND—THE COVER CORES TAKE THE PLACE OF A COPE

FIG. 5—CORE OVENS AND CARS, ALSO COREBOX FOR PLANER BED—THE LARGE PLATES COVERING THE CAR BODIES ARE PLANED PERFECTLY TRUE AND MANY CORES CAN BE MADE WITH SIMPLE FRAMES

they occupy a whole city block approximately 400 feet square. A spur from each of these railroad lines enters the plant from each side affording excellent shipping facilities for the finished product as well as convenience in receiving supplies and raw materials.

The brick foundry building which served the company for many years has been torn down and the new machine shop is taking its place. A modern, up-to-date, foundry of greatly increased capacity has been

FIG. 6—THE FRONT OF THE CUPOLAS, MEZZANINE FLOOR AND CHARGING PLATFORM

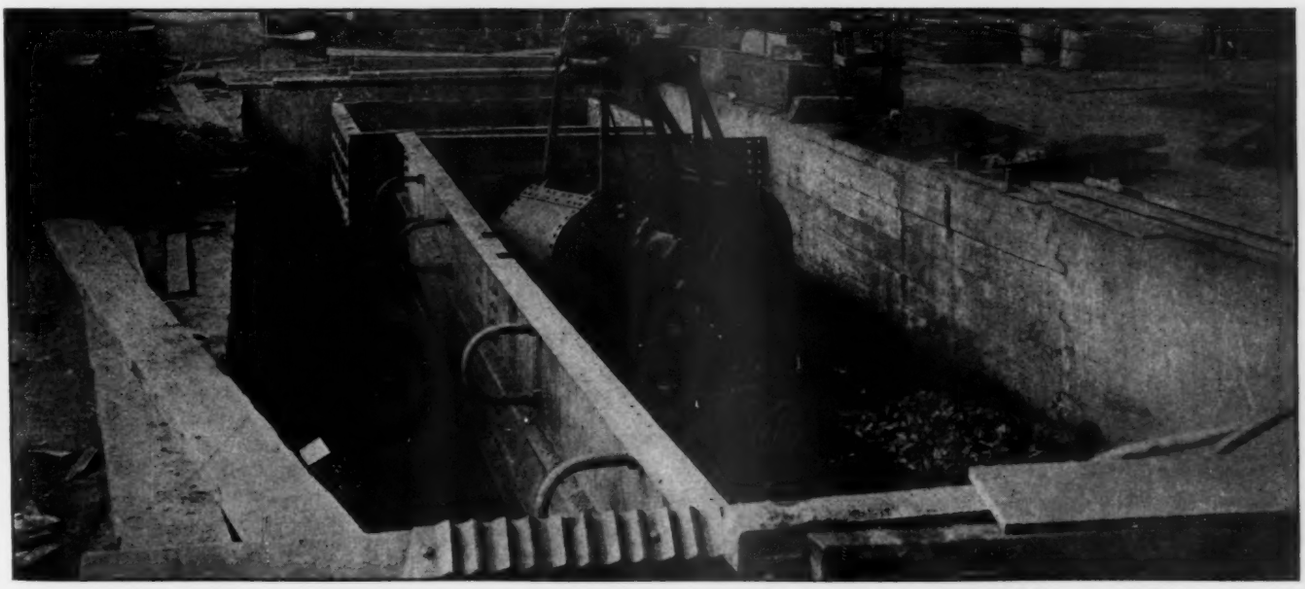


FIG. 7—THIS LARGE CONCRETE PIT APPROXIMATELY 50 x 18 x 5 FEET MAY BE BLOCKED OFF INTO SECTIONS BY A NUMBER OF CHANNELS

erected on the north end of the company's property. It is separate from the new machine shop by the foundry flask yard 45 feet in width and from the street line on the north by the pig iron, scrap and coke storage yard 50 x 370 feet. This yard is spanned by a 10-ton traveling crane made by the Northern Engineering Works, Detroit. Pig iron is unloaded and stacked into piles by the aid of a magnet suspended from the crane and the coke is handled by a clam shell bucket. The charging floor of the cupola is provided with an extension which projects into the yard and the crane is employed to lift materials for the charge onto this platform. From this point, they are carried into the charging room and piled in close proximity to the cupola.

There are instances where the man who charges the cupola or who has charge of the gang which does the charging, knows his business and of course in cases of that kind, the work will be done properly, but in a great many shops at the present time the men who charge the cupolas, when left to themselves to handle the charge, are likely to produce startling results. Uneven charging will result in uneven melting and uneven melting will be reflected in castings that are scrapped on account of cold shuts, blow holes and shrinkage spots due to oxidized metal.

These and other contingencies are met by having each charge of iron made up on a definite pile and by loading the coke in cans. A certain

by the Northern Engineering Works, Detroit, Mich. The light crane travels on a lower track below the others and relieves them of a great deal of light lifting particularly in connection with loading and unloading the core cars. The side bay is divided into three sections occupied respectively by a side floor which is served by a 5-ton Northern crane; the cupola room, which as already stated contains two cupolas and sufficient room for a third; and the core room which also includes the space taken up by the ovens.

A view of the main bay is shown in Fig. 2; from this view it will be seen that most of the work is bedded in the floor. The molds are skin dried either by wood, charcoal, or gas,

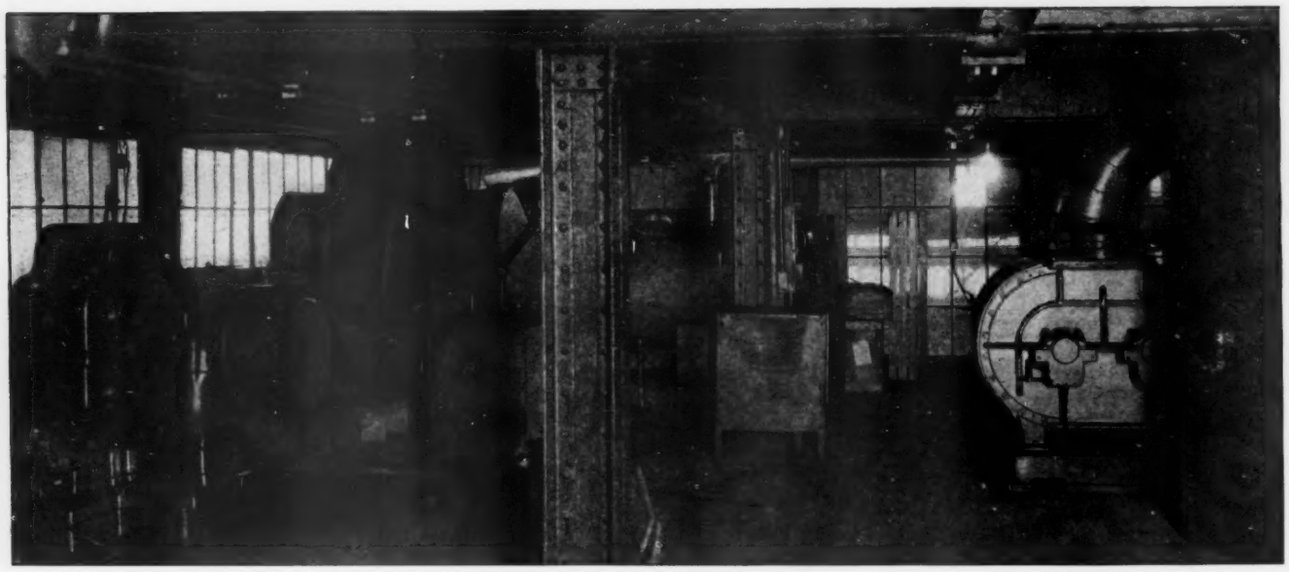


FIG. 8—ELECTRICALLY DRIVEN CENTRIFUGAL COMPRESSOR ON THE LEFT—POSITIVE PRESSURE BLOWER FOR THE 54-INCH CUPOLA ON THE RIGHT—SMALL COMPRESSOR NOT SHOWN

A number of wooden platforms are employed to facilitate making up and handling the charges. They are placed at various points in the yard and the proper amount and quality of iron is placed on each, after which they are picked up by the crane and deposited on the extension platform outside the charging room. The platforms are mounted on two transverse side pieces of plank so that when they are resting on the ground it is possible to run a lift truck under them and convey them to any designated point on the charging floor.

Coke is unloaded from cars by a clam shell bucket and the same bucket is employed to fill the circular cans which are used in making up the charges for the cupolas. It is extremely difficult, as every foundryman knows, to have the coke charged uniformly when it is taken up to the charging platform and dumped there.

number of cans are allowed for each charge of iron and the chances of making a mistake are reduced to a minimum. At the present time two cupolas made by the Whiting Foundry Equipment Co., Harvey, Ill., one lined to 45 inches and the other to 54 inches, are used alternately for melting the iron. The heats run from 25 to 30 tons a day. Provision is made in the foundry layout for an additional cupola 90 inches in diameter when the nature and character of the work warrants the installation.

The foundry measures 90 x 370 feet. Steel and concrete were employed in its construction and, as may be noted in the various illustrations, it is particularly well supplied with lighting and ventilating facilities. The main bay is equipped with two 30-ton electric traveling cranes manufactured by the Whiting Foundry Equipment Co., Harvey, Ill., and one 5-ton crane made

the molds in the floor being covered with sheets of corrugated iron for that purpose and the copes being set on suitable stands such as those shown in the right foreground in Fig. 2. Many of the copes are made of wood and are provided with trunnions on the sides so that they can be rolled over readily. These flasks are relics of the old shop and according as they wear out, they are not repaired but are scrapped and replaced with iron flasks. At the present price of lumber it is claimed that iron flasks are as cheap as wooden ones, and they certainly give better satisfaction over a longer period. Scarcity of lumber long ago forced European foundrymen to adopt the iron flask permanently even for the smallest sizes and the indications are that the American foundries are heading the same way.

Some of the castings made by this

company are large and bulky and a casting pit 18 x 50 x 5½ feet has been provided near the center of one side of the main bay to facilitate handling work of this character. The bottom of the pit and the side and end walls are constructed of concrete, the walls coming flush with the foundry floor. A number of I-beams provided with handles and rows of holes at suitable intervals are employed to block off any desired section of the pit when necessary. In this way there always is a definite rigid enclosure around the body of sand composing the bottom or drag part of any mold and there is no danger that the pressure of metal will strain the walls. Castings made in the floor adjacent to other holes or to pits which have not been filled in and rammed firmly are subject to such a contingency and as some foundrymen know to their cost castings actually have been lost on this account by the metal bursting through the intervening wall. In the rigging under consideration there is no such danger.

Copes Formed With Cores

The copes on all of the jobs made in the pit are held down by cast iron weights which rest on long iron binders extending from side to side of the pit. In the illustration, Fig. 4, it will be observed that no cope has been used. This casting is a section of a 72-inch open-side planer bed which has been cast in the position shown. The cleaned casting is shown in Fig. 3 and the many longitudinal and transverse ribs may be noted.

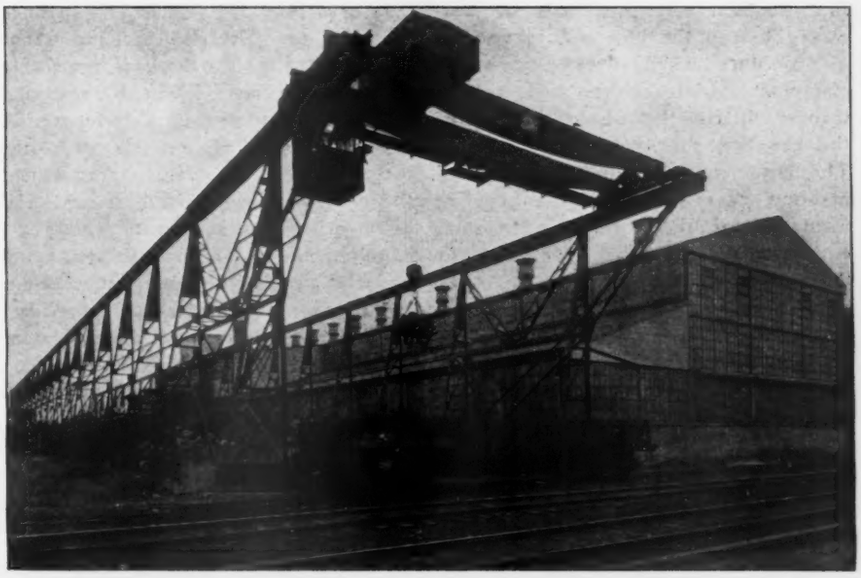


FIG. 10—AN EXTENSION OF THE CRANE RUNWAY FACILITATES UNLOADING PIG IRON AND COKE DIRECT FROM THE CARS TO THE STORAGE PILES—A MAGNET IS EMPLOYED FOR HANDLING THE PIG IRON AND A CLAM SHELL BUCKET IS USED FOR THE COKE

The lower face of the casting is a continuous plate and therefore it is necessary either to support the cores which go to form the ribs on chaplets or suspend them from the cope. The method illustrated here is in general use in the foundries devoted to the production of machine tool castings. In Fig. 5 may be seen the core box on the plate with the core rammed in it, and at A in the right background is one of the cores which has been dried and turned up on its edge. It will be noted that as the core is made on its side an open frame core box is all that is necessary. These cores are provided with cast iron arbors and also with hooks by which they may be picked up and lowered into the mold.

When ramming the drag of the mold, suitable bearings are rammed up at the sides to come flush with the joint and serve as supports to sustain the weight of the cover cores. In some cases, after the cores are all placed, a cope is rammed on top of them and the weights placed on the cope. At other times flat plates are laid on top of the cores; and again the cores are wedged directly from the binder bars which carry the weights.

The grab bucket shown in the illustration, Fig. 7, is used for digging the sand out of the pit before starting a job and it also is used for filling the pit up again after the pattern has been properly set up and ready for ramming. In fact it is one of the most extensively used pieces of equipment in the shop. It is used for filling all the large flasks on the molding floor and the coremakers also use it for filling some of the large coreboxes.

FIG. 9—CHARGING FLOOR—NOTE THE ORDERLY ARRANGEMENT OF ALL THE MATERIALS ALSO THE CANS FOR MEASURING THE COKE

Cores Made on Planed Plates

Two gas fired ovens, each 12 x 24 x 8 feet, supplied by the Ohio Blower Co., Cleveland, are used for drying the large cores while a small coke fired Stevens oven is employed in a similar capacity for the smaller cores. The bodies of the core cars are made of channels bolted together but the top of each car is covered by a large, heavy, cast-iron plate which has been planed perfectly true. Many of the coreboxes are only frames open top and bottom and can be set directly on the plate and rammed full of sand in

that position. It then only is necessary to rap the box and remove it, a procedure which does away with clamping a plate on the box, rolling it over, lifting the whole thing onto the car and then removing the box. The latter method cannot be avoided in some cases owing to the peculiar formation of the core. Under such circumstances plates are clamped onto the box in the usual way.

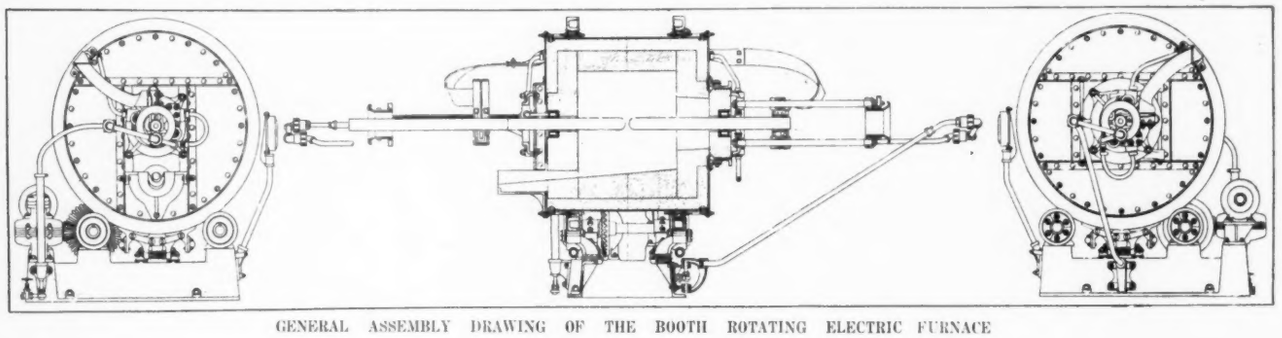
The tracks from the large ovens extend into the main bay and therefore all the large cores are made either on the cars or on the floor in that vicinity. The small cores are made in an adjacent portion of the side bay. This part of the building also houses the sand mixing machinery consisting of a grinding pan supplied by the National Engineering Co., Chicago, and a revolving mixer made by the American Foundry Equipment Co., New York. A supply of sand is kept in large bins at this end of the building. Core sand and facing sand are mixed in considerable quantities and stored in bins near the mixers. The prepared sand is taken from the bins either by the grab bucket or by wheelbarrow and taken to its destination.

As already stated, the cupolas and their accessories occupy the center section of the side bay, 100 x 30 feet. The two cupolas at present in use were supplied by the Whiting Foundry Equipment Co., Harvey, Ill., and are lined respectively to 45 and 54 inches. The blast is supplied by a positive pressure blower which delivers approximately 6600 cubic feet of air a minute. It was made by the P. H. & F. M. Roots Co., Connersville, Ind., and is driven by a 40-horsepower motor. The blower, motors and the compressors which supply the air for the pneumatic tools, etc., are situated on one part of the mezzanine floor. The other end of the floor has been partitioned off and provided with shelves to serve as a store room for chaplets and miscellaneous foundry supplies.

The pig iron and coke storage yard measures 50 x 370 feet and is spanned by a 10-ton electric traveling crane made by the Northern Engineering Works. As may be seen by referring to the illustration Fig. 7, one end of the crane runway extends over the railroad track. By this arrangement the craneman can unload the material directly from the cars to the yard, handling the pig iron with a magnet and the sand and coke with a clam shell bucket. Cars of sand are spotted in front of the rolling doors shown in the end of the building in the same illustration and the sand is shoveled into a series of bins on the inside.

The flask yard lies between the foundry and the new machine shop. It is 45 x 340 feet and is served by a 10-ton Northern crane.

When designing the new building, the comfort and convenience of the employes was not forgotten. A well equipped locker, toilet and wash room has been provided in which every man has an individual locker in which to keep his clothes. The wash basins are supplied with hot and cold water. Three large heaters made by Robert Gordon, Inc., Chicago, are used for heating the shop in cold weather.



GENERAL ASSEMBLY DRAWING OF THE BOOTH ROTATING ELECTRIC FURNACE

Cites Later Type Furnace

By C. H. Booth

We have read with interest the serial articles by H. W. Gillett, of the bureau of mines, entitled "Electrical Melting of Alloys." The information furnished by Dr. Gillett is of great service to the industry, and undoubtedly appreciated by all melters of brass, and those of us who are especially interested in the development of the electric furnace for this purpose.

In article No. 6, appearing in the issue of May 15, a mistake which occurs on page 404, in that the reading headings under Figs. 7 and 8 were transposed; in other words, the line drawing showing the general assembly for the Booth rotating brass furnace was wrongfully given as the general assembly of the Detroit rocking brass furnace. Herewith is shown a revised general assembly drawing of the Booth rotating electric furnace, since the drawing shown in the issue mentioned was that of the first experimental furnace, whereas the drawing attached shows the improved design, complete in all respects.

On page 402 Dr. Gillett in discussing the Detroit furnace, calls attention to the importance where copper is to be melted following a heat of 60-40 yellow brass, of running a suitable wash heat in between the two. With the Booth furnace, by having an extra furnace shell available, it has proved to be a great advantage simply to remove the shell which has been used for melting one grade of material, and to substitute the extra shell when it is necessary to have absolutely no contamination with the metal from one heat to the other. This change can quickly be made. The shell which has been in use simply is lifted off the rollers, and a new shell set in place. In order to save time the new shell can be heated previously by an oil flame so that it is brought up to working temperature before charging..

We are especially interested in comparative records as given in Dr. Gillett's article. One of the recent installations of the 500-pound Booth furnace at the plant of the National Bronze & Aluminum Foundry Co., Cleveland, showed a total output of 3800 pounds of red brass in nine hours, and an average power consumption of 310 kilowatt hour per net ton, including preliminary heating.

The first Booth furnace, which has been in operation for over a year at the plant of Leitelt Bros., Chicago, has not been shut down due to furnace repairs more than two days during the entire period. On two different occasions new linings were installed, but it only took a day's time to reline, since the furnace linings come in only three of four pieces. The first lining lasted 550 heats, and the second lining 660 heats. In both cases no patching was done to the lining in any way.

The Brown Hoisting Machinery Co., Cleveland, has purchased control of the Elyria Foundry Co., at Elyria, O.

Metallurgical Theories Conflict

Complete Bibliography Shows That Investigators Attribute Various Effects to Sulphur and Phosphorus in Steel and Cast Iron— Results Modified by Other Elements

THE joint committee of the several technical societies which is investigating the effect of phosphorus and sulphur in steel has started its work by compiling a complete bibliography on the subject. In presenting the bibliography the committee on statistics calls attention to the fact that nearly all foreign specifications allow a higher phosphorus and sulphur content in steel than is permitted in specifications originating in the United States.

Analyzing the various opinions expressed in the papers reviewed the committee states that it appears although sulphur itself may be a detriment to iron if it exists as iron sulphide, its injurious effect may be neutralized by the presence of sufficient manganese to form manganese sulphide. This compound is said to be comparatively harmless unless it occurs in a segregated form.

Phosphorus is not believed to have decidedly detrimental effects in making steel brittle if the carbon content is low, although an increase of carbon content increases the hardness when both carbon and phosphorus are high and the steel is rendered brittle. Its effect also seems to be modified by the presence of other elements contained in steel. The form in which phosphorus is present also is said to have an effect on the properties of the steel. Stead's investigations lead him to believe that while Mn_3P_2 does exert a powerful influence on the mechanical properties of steel, the phosphide, if well distributed in the ground-mass, is practically without effect.

It also seems to be a generally accepted view of the various writers that these elements are the cause of segregation and hence of unsound steel. Therefore to reduce segregation the content of sulphur and phosphorus should be kept low.

The influence of sulphur and phosphorus on steel has been investigated by many writers in an attempt to correlate the chemical constitution with the physical properties. In general, it has been found that an increase of phosphorus causes an increase in the proportional limit of elasticity and of the ultimate tensile strength; it reduces the percentage elongation and reduction of area, and increases hardness, but when high phosphorus is accompanied by high carbon, a decided brittleness results. The influence of sulphur on these properties is not so pronounced as that of phosphorus although it is generally held not to weaken steel in regard to tensile strength.

Opinion Not Unanimous

Showing that it is not the unanimous opinion of metallurgists that sulphur and phosphorus are injurious, Wasum is quoted as considering 0.10 per cent phosphorus to be harmless, and asserting that 0.15 per cent sulphur is the lowest limit at which red shortness may be expected. Miller, while he believes phosphorus to be injurious considers that sulphur below 0.20 per cent is not detrimental to the quality of the steel. Blow holes which are so often attributed to the action of sulphur, according to Pitman, are due to poor methods of pouring rather than to the sulphur content, while Stead says that sulphur may be regarded as a friend when used intelligently.

The committee calls attention to the fact, that notwithstanding the large number of tests published and listed in the bibliography, the real difference in serviceable properties of two steels that vary for example, by 0.01 per cent phosphorus, is unknown except perhaps in regard to tensile strength. Many articles, it is said, give only the author's views, beliefs or opinions which were formed from limited observations or preconceived ideas. Comprehensive series of tests will be made by the several committeees working on this problem to determine conclusively the effects of these two elements on steel.

The section of the bibliography which pertains to the effect of sulphur and phosphorus on gray iron and on malleable is given herewith. From this it will be seen that opinions differ to quite an extent. This subject well could be as thoroughly studied by foundrymen as the effect of these elements on steel is being studied by this committee. The following list has been arranged alphabetically by authors:

ADAMSON, E. Pig Irons and Their Use. *Iron and Coal Trade Review*, 78, p. 302, 1909. Classifies the various pig irons and briefly considers the effect of carbon, silicon, sulphur, phosphorus and manganese on the tests and grading. Sulphur is not such a deadly enemy as it is often reported to be. Phosphorus retards the rate of cooling at the recalescence points and also lowers the strength of cast iron in transverse test.

ADAMSON, E. Influence of Silicon, Phosphorus, Manganese and Aluminum on the Chill in Cast Iron. *Journal of Iron and Steel Institute*, 69, p. 75, 1906—I. Describes experiments made to determine the influence of these metalloids on chill, and to obtain comparative data on mechanical tests and other conditions. Phosphorus has some influence in reducing the percentage of combined carbon, and decreases the strength in transverse and deflection tests.

ARNOLD, J. O. The Physical Influence of Elements on Iron. *Journal of Iron and Steel Institute*, 45, p. 107, 1894. An investigation of the influence of the elements on the recalescent points showing that the influence is not governed by any periodic law.

BELL, I. LOUTHIAN. On the behavior of phosphorus and sulphur in the blast furnace. *Journal of Iron and Steel Institute*, 2, p. 277, 1871. Says that the undoubted evil produced by the presence of phosphorus or sulphur in iron confers an interest upon any fact connected with their action in a blast furnace.

BELL, I. L. On some of the conditions which apparently affect the quality of the iron. *Journal of Iron and Steel Institute*, 2, p. 288, 1871. Infers the *richness* of iron is, within limits, entirely independent of its chemical composition. However, it is generally thought that an excess of sulphur hardens iron.

BLACKWOOD, P. F. Iron and Its Properties. American Foundrymen's association, Trans, 23, p. 358, 1914. Deals with the principal properties of cast iron and its behavior when alloyed with certain other elements. He also discusses the influence of sulphur, phosphorus, manganese, aluminum and copper on molten cast iron. The red shortness caused by sulphur is due to the absence of a sufficient amount of manganese to form manganese sulphide which reduces the melting point, leaving iron sulphide present in the metal. Phosphorus produces brittleness under shock. It is also a cause of segregation and therefore of porosity. Phosphorus exerts no influence on the carbon in steel.

CARNOT, A., and GOUTAL, E. Notes on the Chemical Composition of Cast Iron and Steel. *Metallographist*, 4, p. 286, 1901. From "Annales des Mines." An account of investigations dealing with the elements. Chemical.

CARPENTER, H. C. H. The Growth of Cast Irons After Repeated Heatings. *Iron and Coal Trades Review*, 82, p. 751, 1911. Considers the effect of sulphur, phosphorus and manganese, and gives report of experiments to find a commercial alloy whose growth is negligible. Phosphide iron grows relatively slowly while sulphur has no appreciable effect.

CHEEVER, B. W. Two Conditions of Phosphorus in Iron. Trans. A. I. M. E., 16, p. 269, 1887. Concludes phosphorus exists in iron in at least two conditions, as phosphide and as phosphate and that the phosphide is the injurious condition; the phosphate being present in the form of slag. The iron should be so produced as to have as much as possible of its phosphorus oxidized to phosphoric acid.

COE, H. J. The influence of phosphorus on cast iron. Staffordshire Iron and Steel institute, 29, 1914.

COE, H. I. The Influence of the Metalloids on the Properties of Cast Iron. *Journal of Iron and Steel Institute*, 87, p. 361, 1913. Sulphur increases the strength in a remarkable manner. There is no evidence that high sulphur content results in the formation of blow holes. Phosphorus affects the chilling action of the sand on irons low in silicon. One-tenth per cent appears to strengthen cast iron but 0.2 per cent results in a hard weak brittle material.

COE, H. I. The Influence of Sulphur on Cast Iron. *Mechanical Engineering*, 30, p. 219, 1912. Briefly considers the reasons for the presence of sulphur in cast iron, its effect on the physical and mechanical properties, the elimination, etc. Resume of Stead's and Levy's work.

D'AMICO, E. Uber den Einfluss des Phosphors auf die Eigensschaften des Flusseisens. *Ferrum*, 10, p. 289, 1912. The increase of 0.10 per cent

phosphorus up to 0.41 per cent affected the quality to the degree as follows: The elastic limit is raised 5200 pounds; the ultimate tensile strength is raised 9200 pounds; the elongation is reduced 1.36 per cent; the contraction of area is reduced 3.81 per cent. Brinell hardness number is increased 12 points.

DILLNER, G. Roheisen fur das Werfen. *Oesterreichische Zeitschrift fur Berg und Huttenwesen, 56*, p. 670. Sulphur makes cast iron hard, white and porous, causing absorption of gases given up on cooling and it should never exceed 0.075 per cent.

EAKINS, E. E. The Chemistry of Cast Iron. *Iron Trade Review, 46*, p. 1030, 1910. *Iron Age, 85*, p. 116, 1910. Discusses heat treatment and the influence of chemical compounds upon the casting. Phosphorus has no effect on the contraction of cast iron except mechanically in enlarging the eutectic mixture. The effect of sulphur depends on the amount of manganese present. In the absence of manganese, sulphur in iron promotes contraction during cooling.

EVANS, G. S. Introducing Phosphorus into Cast Iron. FOUNDRY, *44*, p. 315, 1916. Phosphorus may be introduced in cast iron to affect its fluidity but it is doubted whether it is commercially feasible.

GREENE, A. I. Electric Heating and the Removal of Phosphorus From Iron. American Institute Mining Engineers, Bulletin, Feb., 1913. Explains the metallurgical reactions by which phosphorus can be removed from iron.

HAILSTONE, G. Action of Metalloids on and the Microstructure of Foundry Irons. Proc. S. Staffordshire Iron and Steel Institute, 1907. Sulphur makes iron more fusible and liquid by formation of fluid sulphides; tends to form combined carbon, hardens the iron and produces greater shrinkage; causes blow holes, with high temperature of casting; promotes formation of deep chill, segregation and blow hole.

HATFIELD, W. H. The Constitution of Cast Iron. FOUNDRY, *40*, p. 326, 1912. Dealing with the constituents of cast iron, and some of the changes produced with heat treatment.

HENDERSON, JOSEPH. Note on the Distribution of Sulphur in Metal Ingot Molds. *Journal of Iron and Steel Institute, 1*, p. 286, 1907. Finds the sulphur much higher in the top inch from such molds. Recommends taking chemical analysis samples from the bottom.

HENNING, CAPTAIN. Foundry Iron. *Journal of American Foundrymen's Association, 9*, p. 121, 1901. Showing that chemical and physical investigations are of value to the foundry industry and equally necessary at the blast furnace.

HIORNS, A. H. Influence of Chemical Compounds on the Properties of Cast Iron. *Mechanical Engineering, 24*, p. 170, 1909. Considers the influence of the usual elements found in cast iron.

HOUGHTON, L. Some notes on the chemistry of cast iron. *Iron Trade Review, 39*, 4, 1906. Considers carbon, silicon, manganese, sulphur and phosphorus.

HOWE, H. M. The Constitution of Cast Iron, with remarks on current opinion concerning it. Transactions of American Institute of Mining Engineers, *31*, p. 318, 1901. *Metallographist, 6*, p. 203, 1903. *Engineering and Mining Journal, 96*, p. 511, 1913. An attempt to select the most probable working hypotheses, in studying the relation between the chemical compositions and physical properties.

HOWSON, R. The Art of Puddling. *Journal of Iron and Steel Institute*, p. 575, 1878. Discusses quality of pig iron best adapted for puddling to remove the phosphorus. This is easiest removed from pig low in silicon.

HUDSON, W. J. Behavior of sulphur in the manufacture of iron. Abstract. *Journal of Iron and Steel Institute, 1*, p. 213, 1880. The effect of sulphur on castings is to cause frequent fracturing while the iron is in a half-solid condition.

JOHNSON, G. R. The Action of Metalloids on Cast Iron. Industries and Iron, *25*, p. 208, 1898. Discusses the effect of each element on the properties of the iron and on the state of the other metalloids. Gives tables of tensile tests in which each element in turn is varied, the others being held constant. Ultimate tensile strength increased as sulphur increased but decreased when phosphorus increased.

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LECHATELIER, M. M., and ZIEGLER. Sulfure de Fer. *Bulletin le Societe d'Encour*, 1902. *Metallographist, 6*, p. 19, 1903. A study of the state in which sulphide of iron exists in cast iron, and the nature of its influence on the metal.

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MAULAND, T. Influence of Sulphur in Soft Gray Iron. Transactions of the American Foundrymen's association, *26*, p. 552, 1918. Sulphur considered detrimental though castings containing up to 0.12 per cent sulphur will sometimes be good, strong and soft. At other times castings are hard with less than 0.09 per cent sulphur. Hence, sulphur is not the determining factor in hardness. His results seem to show sulphur is not as detrimental as it is usually represented to be.

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MESSERSCHMITT, A. Uberdie Schwefelverteilung in Gusstucken und deren Einfluss auf den Werkzeugmachinenguss. *Stahl und Eisen, 25*, p. 894, 1905. Discusses the difference in sulphur distribution in a casting, when poured from above or from below.

MOLDENKE, R. Cast Iron. *Railroad Gazette, 31*, p. 171, 1899. Considers chemical properties, the making of tests, etc.

PARDUN, C. Ueber das Verhalten des Schwefel beim Kupolofen-schmelzen. *Stahl und Eisen, 31*, p. 665, 1911. A large amount of sulphur in the coke passes over to the iron first melted. It is nearly impossible to prevent this but the addition of manganese may aid.

PEARSE, J. B. Iron and Carbon, Mechanically and Chemically Considered. Transactions of the American Institute of Mining Engineers, *4*, p. 157, 1875. Gives tensile test results and chemical analyses of cast iron guns. Phosphorus decreases the tenacity.

PORTER, J. J. Influence of Various Elements on the Properties of Cast Iron. Transactions of American Foundrymen's association, *19*, p. 35, 1911. *Iron Trade Review, 49*, p. 839, 1911. *Iron Age*, 88, p. 1077, 1911. The chief factors which influence fluidity are the sulphur and phosphorus percentages, absence of dissolved oxide, and height of temperature to which the iron is heated above melting point.

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RHEAD, G. L. Segregation in Castings. *Ironmonger, 138*, p. 314. Phosphorus is the most fusible element in iron and consequently lowers the melting point of iron more than any other substance contained by the iron. The brittleness of phosphoric iron when cold, unfits the castings for heavy machinery.

ROSENHAIN, W. The Distribution of Phosphorus in Cast Iron. *Met. and Chem. Engineering, 12*, p. 650, 1914. Describes method of etching to show the presence of phosphorus in cast iron.

SCOTT, W. G. Effects of Variations in the Constituents of Cast Iron. FOUNDRY, Sept., 1902. Describing the influence of metalloids on cast iron as observed under practical conditions without reference to theory.

STADELER, A. Zur Metallurgie des Gusseisens. *Stahl und Eisen, 31*, p. 933, 1034, 1916. Reviews the work of Ledebur, Keep, Wust and others on the influence of the various elements on cast iron.

STEAD, J. E. The Effect of Sulphur and Silicon on Cast Iron. *Nature, 84*, p. 302, 1910. Discusses the effect of these substances on the carbon content of commercial cast iron from the metallurgical point of view.

TURNER, T. Silicon and Sulphur in Cast Iron. *Journal of Iron and Steel Institute, 1*, p. 28, 1888. On the mutual interaction of silicon and sulphur. It appears probable that with a certain percentage of silicon there is a definite amount of sulphur which cannot be exceeded under given furnace conditions. In a blast furnace, a low temperature favors the union of sulphur and iron. The composition of the slag influences the sulphur content.

G. B. W. Effect of Sulphur in Cast Iron. *Iron Age, 96*, p. 1551, 1915. Quotes from Prof. E. Legur's article in *Stahl und Eisen*, Jungst in "Contributions to the Investigation of Cast Iron" and Coe in the *Journal of Iron and Steel Institute*, to show the effect of sulphur depends upon presence of carbon and silicon. Data.

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WEST, T. D. Effects of Expansion on the Shrinkage and Contraction of Iron Castings. Transactions of the American Institute of Mining Engineers, *26*, p. 165, 1896. Tests show sulphur is harmful in cast iron; 0.20 per cent sulphur being enough to injure or ruin almost any casting.

WEST, T. D. Diffusion and Segregation of Metalloids at the Furnace and Foundry. *Industries and Iron, 19*, p. 502, 1895. Methods of lessening their evil effects. Variation in composition is discussed.

WUST, F., and MINY, J. Uber den Einfluss des Schwefels auf die mechanischen Eigenschaften des grauen Gusseisens. *Ferum, 14*, p. 113, 1917. The action of sulphur is dependent upon the manganese content but not on the silicon content. High sulphur castings show no more proneness to porosity than do low sulphur castings. Hardness rises with increasing sulphur.

WUST, F. and STOTZ, R. Uber den Einfluss des Phosphor die mechanischen Eigenschaften des graven Gusseisens. *Ferrum, 12*, p. 89, 1914-15. Investigation of the influence of phosphorus on gray cast iron. Test bars with various percentages of phosphorus were prepared. The transverse test gave a mean breaking strength from 39.60 kilograms per square millimeter for 0.16 per cent phosphorus down to 25.80 with 2.04 per cent phosphorus. The hardness at the same time increased from 234 (Brinell) to 327.

WUST, F. Uber die Abhangigkeit der Graphitausscheidung von der Anwesenheit fremder Elemente in Roheisen. *Metallurgie, 3*, p. 200, 1906. The solubility of carbon in iron is lessened by sulphur, but sulphur does not promote its conversion to temper carbon; on the contrary, it neutralized the action of silicon in this respect.

Malleable Cast Iron

DAVIS, P. H. Effects of Phosphorus on Malleable Cast Iron. FOUNDRY, *47*, p. 258, 1919. Discussion of Mr. Teng's and Professor Touceda's paper on this subject.

HEMENWAY, H. Calculating Mixtures for Malleable Cast Iron. American Foundrymen's association, transactions, *23*, p. 413, 1915. Phosphorus in connection with silicon has an influence on the fluidity of iron. There will be no bad effect if the amount of phosphorus present does not exceed 0.20 per cent. There are no beneficial results arising from the presence of sulphur and it should be less than 0.045 per cent.

MERRICK, A. W. Sulphur Reduced in Malleable Iron. FOUNDRY, *47*, p. 685, 1919. Finds slag lowers sulphur.

SMITH, R. H. Sulphur in Malleable Cast Iron. *Journal of Iron and Steel Institute, 92*, p. 141, 1915. *Iron Age, 96*, p. 1235, 1915. Research to ascertain if sulphur is removed by annealing and what conditions favor removal. Sulphur does not appear to have any markedly injurious effects on the product until about 0.15 per cent is present. Higher percentages give unsatisfactory bending tests and low deflections.

TENG, J. H. Phosphorus in Malleable Cast Iron. *Journal of Iron and Steel Institute, 98*, p. 349, 1918. Investigations undertaken to determine the effect of proportions of phosphorus

(*Concluded on page* 495)

Rigging Heavy Repetition Work

BY PAT DWYER

ALTHOUGH situated in a small Ohio city, a thousand miles from salt water, a certain foundry connected with a large engine works, established an enviable record a year or so ago by producing one complete set of castings for a 2800-horsepower marine engine every day continuously for several months. The machine shop department of the same plant machined, assembled and shipped four engines a week, complete in every detail down to the last cotter pin, and ready for installation in any of the ships at that time under construction by the Emergency Fleet corporation. This was a remarkable exhibition of team work in manufacturing and further of what a competent, resourceful foundry manager can do when given *carte blanche* and allowed to build without stint. The rigging provided for making these castings was expensive, comparatively speaking, but the initial cost was quickly absorbed in the rapid and increased production made possible by its adoption. The story of how this was accomplished was published in the April 15, 1919, issue of THE FOUNDRY. The methods adopted for handling this marine engine work are typical of the man in charge. He believes in providing the best and most accurate rigging and as a great deal of the work is of a more or less repetitive character, known in the foundry as running jobs, he has had many opportunities to exercise his ingenuity in this respect. An interesting example of work on which comparatively expensive rigging was justified, is shown in the accompanying illustrations which show successive steps in making a gas pro-

FIG. 1—THE COPE PLATE IS PROVIDED WITH LUGS FOR ROLLING IT OVER

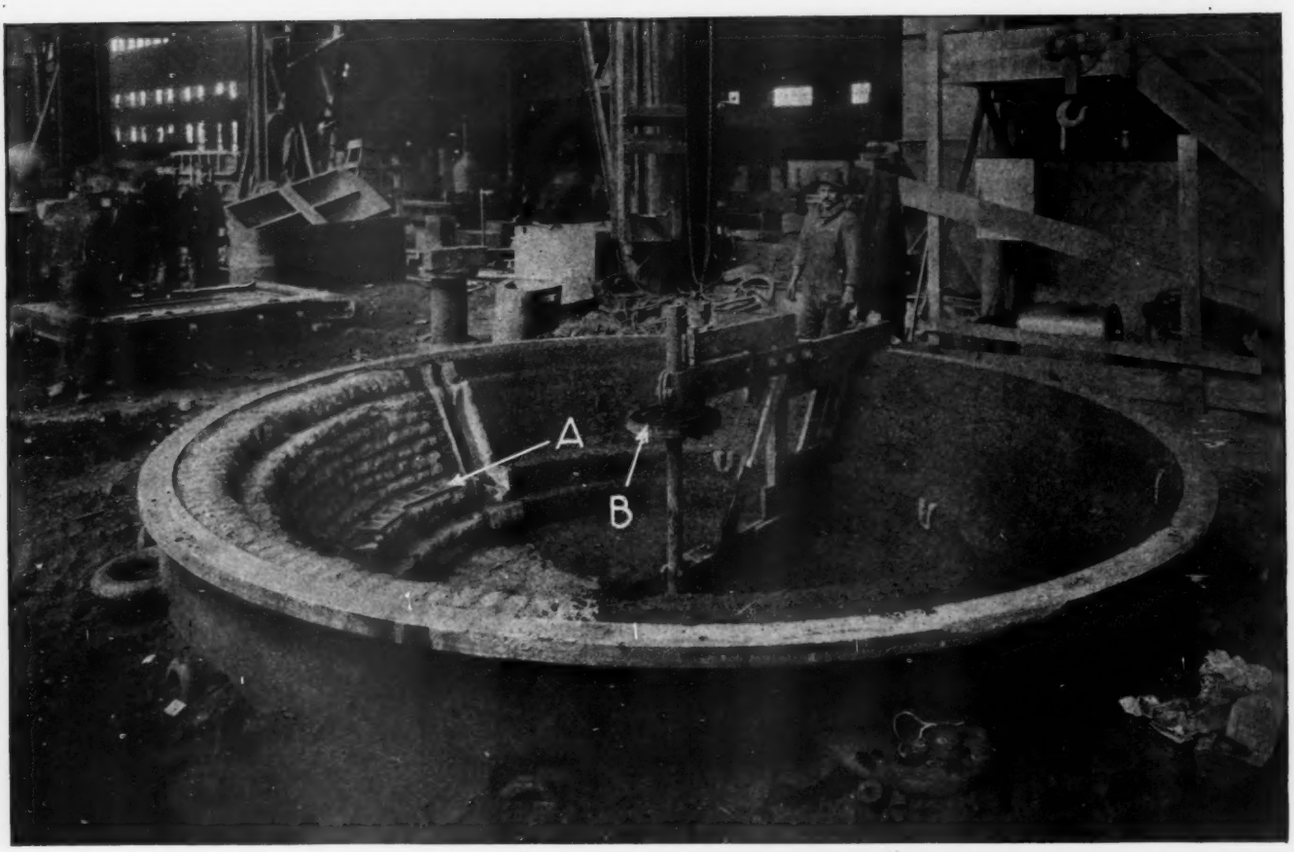


FIG. 2—DRAG PARTLY LOAMED—NOTE THE GRIDS AT *A* FOR REINFORCING THE WALL AND THE SPECIAL GUIDE PLATE ON THE SPINDLE AT *B*

ducer ash pan. This casting is approximately 12 feet in diameter by 3 feet deep in the center with a metal thickness of 7/8-inch. This is a job that would take a molder a week or ten days to make under ordinary circumstances. With the aid of the rigging shown one molder casts an ash pan every second day. The first order for this job called for 90 castings and the second specified 200 so it is easily seen where the saving in time offsets the cost of the rigging.

The rigging provided for molding the job consists of a heavy circular cast iron bottom plate, 15 feet 4 inches in diameter with 12 staples cast in as many lugs distributed at equal intervals around the perimeter. These act as anchors in binding the mold together. One cast-iron flask section 14 feet 4 inches inside diameter provided with flanges top and bottom is provided. The top flange was machined to a true face and had holes drilled at diametrically opposite sides to receive the guide pins when closing the mold. On account of the casting being split in two the mold is not a true circle but has a flat space on each side. It therefore is necessary to provide means for closing the cope accurately and in the proper relative position to the drag. The guide holes were drilled diametrically opposite each other on a center line; the cope, spindle bearings and other measurements were determined from the same line; and then, to insure against the possible error due to turn-

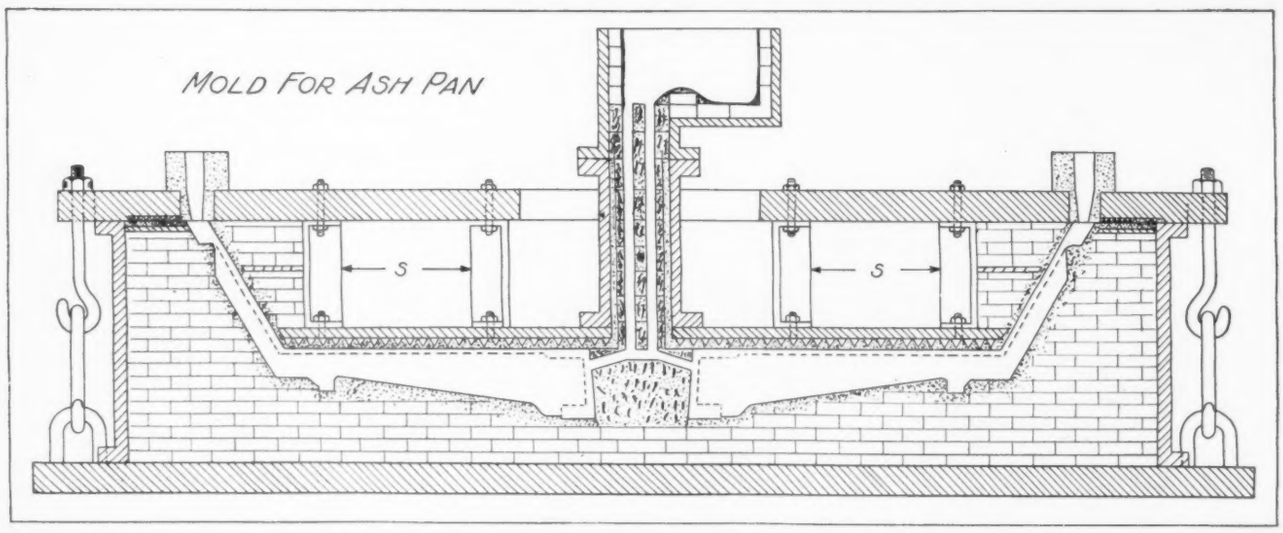


FIG. 3—SECTIONAL DRAWING SHOWING THE MOLD ASSEMBLED READY FOR POURING THE STANDARDS SHOWN AT *S-S* RENDER THE LIFTING PLATE ABSOLUTELY RIGID

ing the cope end for end, a second hole was drilled near one of the first on one side only. Thus by having two holes on one side and only one on the other there is no possibility of making an error in closing the mold.

The cope plate has the same general dimensions as the bottom plate. It is provided on opposite sides with a pair of substantial lugs in which to fasten the clevises when rolling it over. Their application together with the other general features of the plate are shown in the illustration Fig. 1.

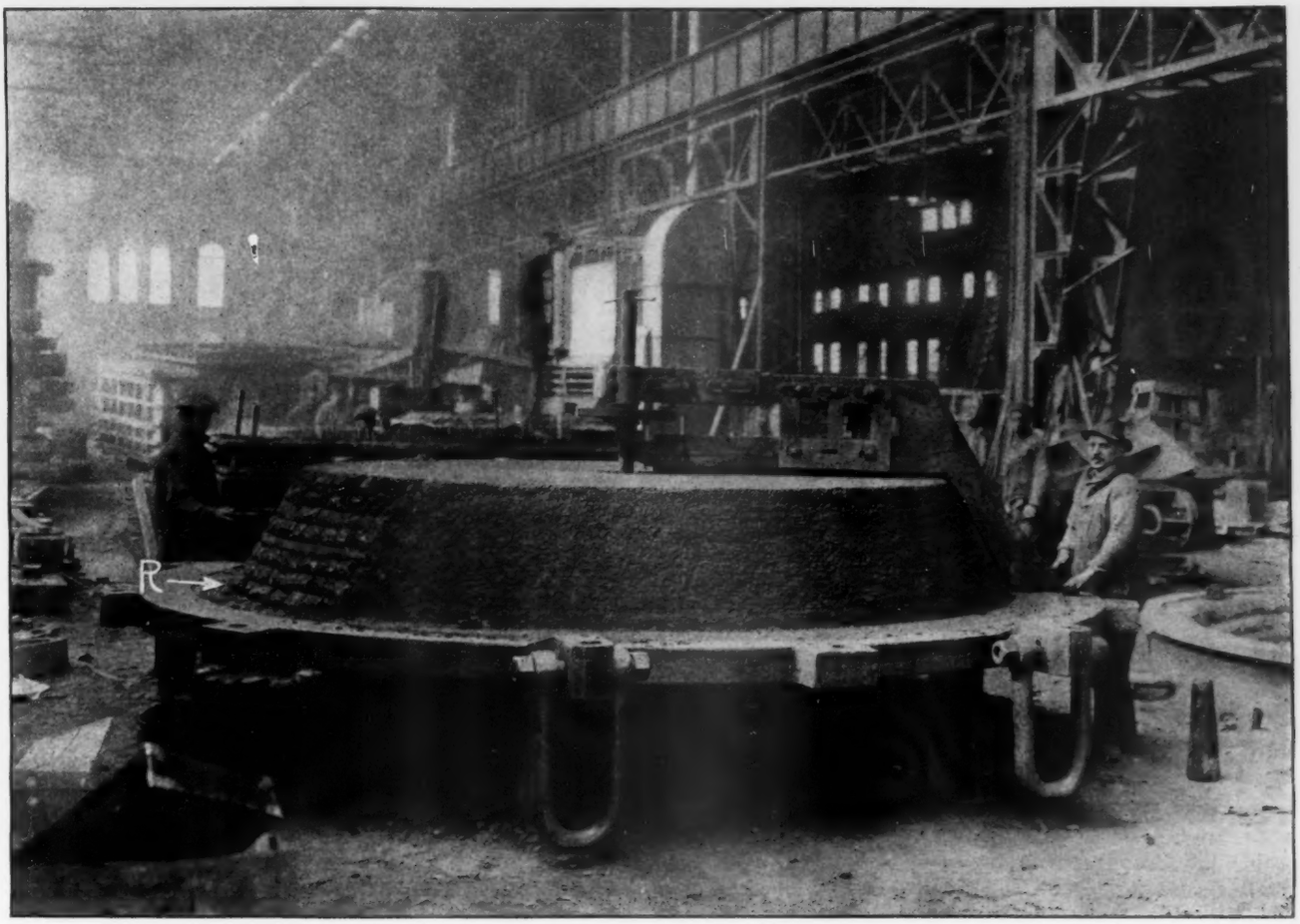


FIG. 4—COPE PARTLY LOAMED—PART OF THE COPE PLATE JOINT IS PLANED BUT THE REMAINDER IS RECESSED AND PROVIDED WITH A CHANNEL TO CARRY THE LOAM AS SHOWN AT *R*

This plate is not solid but is provided with a 40 inch opening in the center which is more plainly evident in Fig. 5. This opening was found to be an aid when assembling the cope and face plates. It was designed primarily as a convenience in setting and securing the runner box which as may be seen from the illustration Fig. 3, is made up separately from the rest of the mold and afterward lowered through the central hole in the top plate until it rests on the face plate as shown in the same illustration. The prickered face plate which forms the inside bottom surface of the pan and also carries the lift is attached permanently to the cope plate by six cast-iron standards shown at *S* Fig. 3. These standards serve a double purpose. They carry the face of the mold and also prevent it from springing under the pressure of molten iron while the casting is being poured. This plate is provided with a 9-inch opening in the center to accommodate the runner core which forms a continuation of the upright runner.

As may be noted from several of the illustrations the casting is a flat bottom pan with sloping sides and reinforced on the exterior of the bottom by a number of ribs which radiate from the center. For convenience in shipping the casting is made in two halves but is poured as a unit. The joints on each side are afterward machined to a true fit, bolt holes drilled in the flanges and the pan assembled. It is then taken apart and shipped to its destination where it is again assembled and placed in position in the base of a gas producer installation.

The radial cores which form the ribs on the bottom of the pan are made on plates which have been machined absolutely flat on the face side. Instead of providing individual prints on the bottom face of the mold for each core, one large common print is provided to receive them all. All the cores are made with shoulders on the sides which determine the shape of the bottom edges of the ribs and also space them automatically. The cores which form the lugs on the sides and which also carry the prints for the side *splitting* cores are located and tucked into place with the first rough coat of loam. They in turn serve as a guide in setting the remainder of the cores after the mold has been dried and cleaned out.

The face of the cope plate was machined to a true face for a distance to correspond with the width of the top flange on the flask section which serves as a drag. Pin holes were drilled on a center line which coincides with the center line on the drag. In this way both halves of the mold were made independently of each other but are fitted together as closely and accurately as if one part had been built on top of the other.

In molding work of this character, where a common circumference is struck from more than one center a spindle and guide plate, similar to the

one shown in Fig. 2, is used. The spindle seat carries a square opening in which the foot of the spindle is held rigidly and prevented from revolving with the action of the arm. The guide plate *B* is attached to the spindle by a set screw. It is adjusted to the proper height after the arm and sweep have been set. The sweep is attached to the arm by four bolts which move freely in a horizontal direction in slots in the arm. The sweep is guided, in its path around the mold, by a pin on the lower edge which is held to a certain course by the groove in the guide plate. The lower arm on the sweep simply is slotted to fit the spindle. The spindle seat used on the cope is provided with three long legs which span the opening in the center of the cope plate. It has to be taken off each time the mold is assembled for pouring and put on again each time the mold is repaired. To insure that it always is set in the correct position, two of the bolt holes by which it is fastened to the cope plate are made alike but the third is much smaller and requires a different sized bolt. Thus it is readily apparent that it will fit only in one position and that is in the way in which the parts were laid out and assembled at the start. The spindle employed on the cope of course, is provided with a guide plate similar to that used on the drag and attached to the spindle in the same relative position.

After the rigging had been prepared and tried for accuracy a large hole was dug in the foundry floor about 2 feet deep. The bottom plate was lowered into this hole and adjusted until it was approximately level. The drag section of the flask was set on next and leveled absolutely, 1-inch pieces of iron being placed between the plate and the bottom flange at the points near the anchor bolts. This was done to provide an avenue of escape for the steam generated while drying the mold and for the gas while the mold was being poured. Several short lengths of pipe were arranged in a vertical position to convey the steam and gas away from the opening between the flask and the plate and then the hole was filled with sand and rammed.

The mold was bricked up in the usual way, using the sweep for a guide. Setting the sweep was simplified as it was only necessary to let the outer extremity rest on the flange of the flask and then level the arm. After the first setting, the arm, sweep and spindle were not disturbed in relation to each other. The mold was given a rough coat of loam then a thin coat of slurry after which the crane was hooked to the spindle by a bar shoved through a hole near the top and spindle and sweep were lifted out and placed to one side until after the casting had been poured and shaken out. They then were replaced and the same procedure gone through with again.

When building the mold, the brick work is left quite open, cinders are used freely and generous vent passages provided to allow gas to escape from the cores used to form the ribs on the bottom of the pan. These cores are covered with metal on the top and on the sides and it thus is necessary to carry off the vent through the bottom of the mold. The cores are prevented from rising by a number of stud chaplets which are set on before the mold is closed. Each chaplet is the exact thickness of the metal in the bottom of the pan and therefore when the cope is closed, the lower face bears on the chaplets which in turn hold the cores in their places.

As may be seen, by referring to the illustration Fig. 3, the core which forms the circular opening in the center of the pan is provided with gates for running the casting. It also is provided with a shoulder which projects into and fills the opening left in the cope face plate for that prupose. The top of the shoulder comes flush with the inside surface of the plate and therefore when the runner box is lowered into place the bottom surface comes into intimate contact with the top of the core and forms a tight joint. The runner box is formed in two parts, the pouring basin and the upright portion. Each of these is bricked on the inside and only requires a little patching each time it is used to make it serviceable. Four risers are taken off the rim. They appear to be much heavier than necessary on a thin casting like an ash pan until it is learned that their chief purpose is to support and lift the casting from the mold at the same time the cope is lifted off.

At night after the casting has been poured the anchor bolts are removed, the crane hooked on to the lugs of the covering plate and both plate and casting lifted as one load. The casting hugs the cope tightly and with the support afforded by the four risers may be carried to a suitable point on the floor where it is lowered down and rapped loose. The casting is left lying on the floor and after the three-legged spindle seat has been bolted to the plate the latter is rolled over and set up on blocks ready for the molder to start another mold the next day.

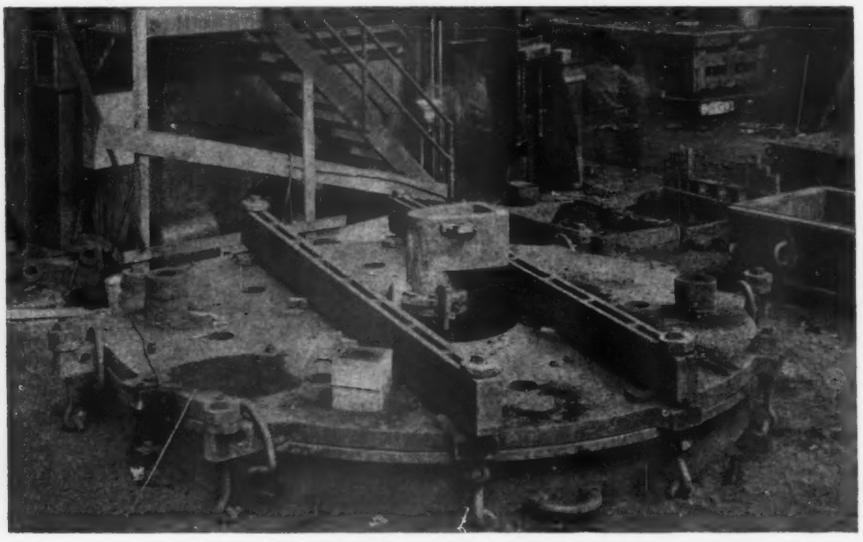


FIG. 5—THE COMPLETED MOLD IS BOUND FIRMLY TOGETHER AT 12 POINTS ON THE CIRCUMFERENCE AND BY TWO BINDERS ACROSS THE CENTER

Combination for Research Urged

That the malleable iron industry is not on as strong a footing in Great Britain as it should be was indicated in a paper presented at a recent meeting of the Coventry branch of the Institute of British Foundrymen, by F. S. Lantsberry. Manufacturers were urged to join for the purpose of spreading the knowledge of malleable now available and to carry on research work along this line. An organization for these purposes, it was said, could obtain assistance from the government which had voted a million pounds sterling, approximately $4,000,000 for industrial research.

One of the difficulties with which users of malleable are confronted is castings which do not machine readily. This was said to be due either to under annealing or to over annealing.

Under annealed castings could be softened by reannealing, but the author had found that reannealed castings were likely to be over annealed on the second anneal. The object of the anneal in making white-heart malleable is to remove the carbon and the author said that the temperature is carried to from 900 to 1000 degrees Cent.

A characteristic of white heart malleable is the large amount of sulphur which may be present without injuring the casting. This is shown by some analyses of white-heart malleable which Mr. Lantsberry gave as representing the wide range of composition in malleable iron as made by three different manufacturers. In these analyses which follow, it may be noted that the phosphorus and manganese are lower on the average than is the custom in making black-heart malleable.

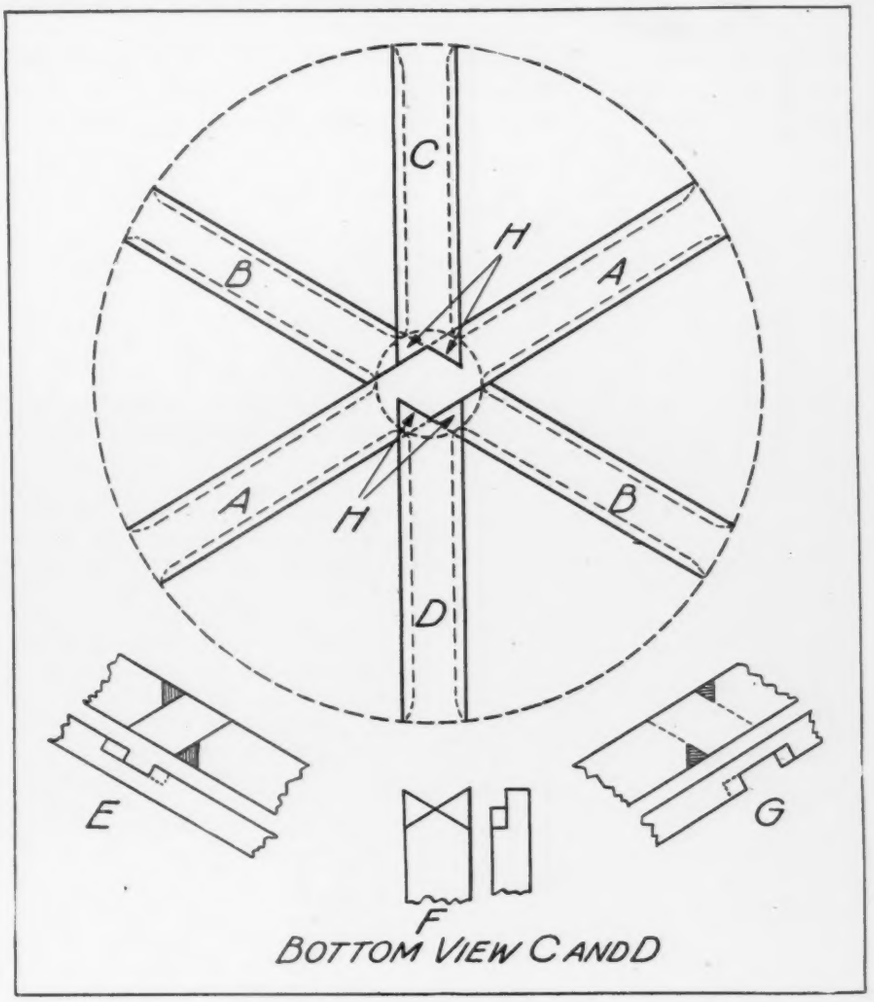
Silicon	1.12	0.74	0.78
Sulphur	0.22	0.186	0.129
Phosphorus	0.042	0.060	0.073
Manganese	0.11	0.14	0.15
Silicon	0.60	1.28	1.03
Sulphur	0.35	0.356	0.19
Phosphorus	0.056	0.075	0.058
Manganese	0.20	0.16	0.08
Silicon	0.32	0.73	1.11
Sulphur	0.17	0.38	0.137
Phosphorus	0.084	0.056	0.070
Manganese	0.07	0.52	0.15

Methods of Constructing Strong Arm Joints

By Arthur Landerer

To provide strong and perfectly fitting joints is one of the principal aims of a good pattern maker. The shape, size and general character of the pattern determines just what style of joint is most suitable. In making the hub and arms of an ordinary wheel it is customary to cut the hub ends of the arms on radial lines and have the points all meet at the center. The hub is attached firmly and permanently to these parts and binds them together. In some cases where it is desired to use various sized hubs with the one set of arms some other method must be adopted for binding the ends of the arms together since the hubs are loose and detachable. The type of joint shown in the accompanying illustration is well adapted to this purpose.

Four pieces of stock are dressed to the required width and thickness. Two of these pieces, *AA* and *BB*, are made the full diameter of the wheel and the other two pieces, *C* and *D*, are cut to a length equal to half the diameter less half the width of the hub. *AA* and *BB* are slotted across the center, *AA* on the bottom and *BB* on the top side, as shown at *E* and *G*. They are then assembled in their proper relative position by placing them on a layout board which has been marked in a suitable manner for that purpose. It is optional whether they are glued and nailed at this time or after the remaining arms have been fitted. In either case they are tacked to the board temporarily. The triangular 60-degree pieces shown in black in *E* and *G* are checked out half way through the thickness. The inside ends of *C* and *D* are then cut to fit and also checked half way on the corresponding triangular points as shown. After all the pieces have been fitted accurately they are glued, and if considered necessary, nailed or screwed together.



IN THIS ARM JOINT, *A A* AND *B B* ARE FULL LENGTH PIECES EXTENDING FROM SIDE TO SIDE AND HALF CHECKED IN THE CENTER WHILE *C* AND *D* ARE HALF CHECKED IN AT THE ENDS AS SHOWN AT *H H*

The dotted lines indicate the stock which has to be removed to make the desired shape of the arms. This is done after the glue has set, when the assembled arms can be removed from the layout board and fastened in the vise for convenience in tooling.

The Lawrenceville Bronze Co., Pittsburgh, with a plant at Zelienople, Pa., which was reorganized about 18 months ago, has increased its furnace capacity. A special meeting of the stockholders will be held June 28, to consider an increase in the capital from $200,000 to $1,000,000.

Issues Booklet on Brass

An interesting and artistic booklet of 78 pages, printed on heavy coated paper, entitled *Seven Centuries of Brass Making* has been issued recently by the Bridgeport Brass Co., Bridgeport, Conn. It reviews briefly the history of ancient brass making and contrasts the early and even recent methods of production with the modern electric furnace process. Comprehensive descriptions, illustrated from reproductions from numerous excellent photographs, are given of the methods usually employed for casting brass, followed by the reasons which actuated the company in discarding the crucible process, tearing down the high brick stacks and installing a battery of electric furnaces for melting purposes.

The sequence of operations and the equipment necessary to convert the cast brass ingots into commercial rolled shapes, sheets, rods, wire, tubes, etc., is described at considerable length and freely illustrated. Laboratory and research departments; characteristics and structure of brass are described.

Standard Foundry Cost System—III

Plant Investment Classification Is Outlined in Section II — Depreciation Rates for Buildings and Equipment, General Ledger Accounts Are Listed—Comments Regarding Starting Cost Work

COMPILED BY
C. E. KNOEPPEL & CO., INC.
NEW YORK

AS FAR as practicable the following plant investment accounts should be carried in the general ledger, the opening entries being based on the first cost or replacement value of the investment in each class. If such value is not determinable, an appraisal of the physical property should be made. The classification is intended to provide more than an analysis of the plant investment but to afford: *First,* a means of classification for depreciation group rates; *second,* a basis for classification of maintenance charges, and *third,* a means of establishing reserves corresponding to each plant investment account.

1. Land.
2. Buildings and structures.
3. Cupolas, ovens and furnaces.
4. Piping and wiring.
5. Machinery and tools—cataloged.
6. Machinery and tools—miscellaneous.
7. Electrical equipment—cataloged.
8. Electrical equipment—miscellaneous.
9. Shafting, pulleys, hangers and belting.
10. Special machinery, jigs, fixtures, punches and dies.
11. Shop fixtures and equipment—miscellaneous.
12. Railway tracks and overhead equipment.
13. Rolling stock.
14. Trucks, teams and other conveyances.
15. Patterns.
16. Metal flasks.
17. Office furniture and appliances.
18. Power plant equipment.

These accounts should be consolidated for presentation on the balance sheet and shown as one amount against plant investment. Corresponding reserves should also be consolidated on the balance sheet and shown as general reserve for plant depreciation.

If desired only two groups may be used; i. e.,

Real estate and buildings.
Machinery and equipment.

SECTION VIII
DEPRECIATION

For convenience, the schedule of depreciation rates given in first bulletin is presented in the accompanying table for what assistance it may give.

It must be borne in mind, however, that new government rulings are constantly being made and that all rulings as to depreciation should be carefully watched. As stated elsewhere in this series of articles absolute accuracy in all details is essential to success.

SECTION IX
GENERAL LEDGER ACCOUNTS

The schedule of general ledger accounts on the following pages is such as would be required to reflect the details of an average foundry. Sub-accounts or additional accounts should be added to represent classes of transaction special to any particular foundry. The schedule and definitions are merely illustrative of the principles involved.

The accounts appear under the following groups which are in the sequence required for presentation on the balance sheet and profit and loss statement.

1. Current assets.
2. Inventory assets.
3. Fixed assets.
4. Deferred assets.
5. Intangible assets.
6. Current liabilities.
7. Fixed liabilities.
8. Reserves.
9. Capital liabilities.
10. Surplus and profit and loss accounts.
11. Financial profit and loss accounts.
12. Operating expense accounts.
13. Sundry and general ledger accounts.

The following detailed accounts are suggested for the general ledger. These may be amplified as much as desired, or as the business demands.

1—*Current Assets:*

1—Cash in bank (an account for each bank).
2—Petty cash.
3—Notes receivable.
4—Accounts receivable.
5—Bonds and other investments.

2—*Inventory Assets:*

1—Melting stock metals.
2—General stores (or as many as desired).
3—Finished castings.
4—Work in process.

3—*Fixed Assets:*

1—Machinery and equipment.
2—Real estate and buildings.

4—*Deferred Assets*

1—Unexpired insurance.
2—Unexpired taxes.
3—Prepaid interest.

5—*Intangible Assets:*

1—Patents.
2—Good will.

6—*Current Liabilities:*

1—Notes payable.
2—Accounts payable.
3—Accrued payroll.
4—Accrued taxes.
5—Accrued commission.
6—Accrued interest.

7—*Fixed Liabilities:*

1—Bonds payable.
2—Mortgages payable.

8—*Reserves:*

1—Reserve for depreciation on machinery and equipment.
2—Reserve for depreciation on buildings.
3—Reserve for bad debts.

9—*Capital Liabilities:*

1—Capital stock—preferred.
2—Capital stock—common.

10—*Surplus and Profit and Loss Accounts:*

1—Surplus.
2—Income and excess profits account.
3—Dividends—preferred stock.
4—Dividends—common stock.
5—Profit and loss.
6—Adjustment account.
7—Castings sales.
8—Cost of castings sales.
9—Miscellaneous sales.
10.—Cost of miscellaneous sales.
11—Freight out on sales.
12—Administrative expense.
13—Selling expense.

11—*Financial Profit and Loss Accounts:*

1—Interest received.
2—Discount taken.
3—Interest paid.
4—Discount given.
5—Interest on investments.

12—*Operating Expense Accounts:*

1—Cost of melt.
2—Cost of melt credits.
3—Molding burden—direct labor.
4—Molding burden—direct labor credits.
5—Molding burden—machine hour.
6—Molding burden—machine hour credits.
7—Molding sand cost.
8—Molding sand cost credits.
9—Flask cost.
10—Flask cost credits.
11—Coremaking burden—direct labor.
12—Coremaking burden—direct labor credits.
13—Coremaking burden—machine hour.
14—Coremaking burden—machine hour credits.
15—Finishing cost.
16—Finishing cost credits.
17—Annealing cost.
18—Annealing cost credits.
19—Power, heat and light expense.
20—Pattern shop expense.

21—General expense.
22—Expense ledger.
13—*Sundry General Ledger Accounts:*

Credits—
(1) Total amount of checks issued during the month.

Debits—
(1) With the value of checks drawn to create or to increase the

Depreciation Schedule

When a Piece of Equipment Outlives Expected Life, Establish Scrap Value and Make no Further Charge for Depreciation

A	
Alarm signal boxes	7½
Anvils	5 to 10
Arresters, lightning	10
Axes, fire	10
B	
Barrels, steel tumbling	10
Baths, shower	10
Bearings, ordinary shaft hanger, babbitt	Expense
Bearings, roller, on line shaft	10
Belts, fast running—short life belts	Expense
Belts, lacing machines	10
Belts, main and ordinary drive	5 to 20
Benches, iron	5
Benches, wood	10
Bins, steel	5
Bins, wood	10
Blackboards, attached to wall	10
Blackboards on iron standards	10
Blower exhaust, laboratory	10
Blower system, furnaces	5
Boards, directory and planning	10
Boiler, steam power	5 to 7½
Boiler tube expanders	10
Boring machine, pattern	5
Boxes, annealing	Expense
Boxes, tote, steel	20
Boxes, tote, wood	Expense
Buildings, brick	2 to 5
Buildings, brick and wood	3 to 5
Buildings, concrete, reinforced	2 to 3
Buildings, steel frame, brick walls	2 to 3
Buildings, wood	5 to 10
Bumpers (See jarring machines)	10
Burners, gas—under boiler	5 to 7½
C	
Cars, annealing furnace	10 to 20
Cars, core oven	5
Cars, foundry trucking	10
Chemical laboratory apparatus	10
Chutes, loading and unloading	10 to 25
Clocks	4 to 10
Closets, toilet	10
Clutches, friction	10
Compresses, air	7½
Controllers, elect. circuit	10
Conveyors	10 to 20
Couplings, line shaft	10
Crane track	5
Cranes, swing	7½
Cranes traveling	7½
Cupolas, steel	5
Cutters, bolt	5 to 10
Cutters, sprue	7½
Cutters, stencil	7½
Cutting apparatus, acetylene generation	10
Cutting apparatus, acetylene tools	Expense
D	
Drill presses, multiple	7½
Drill presses, ordinary	5
Drinking fountains	10
Dust collecting systems	7½
E	
Elevators	7½
Engines, steam or gas	4
Exhaust heads	5 to 10
Extractors, oil	5
F	
Fans, ventilating	7½
Feeders, boiler compound	7½
Filters, oil	5
Fire apparatus	10
Flasks, aluminum	10
Flasks, cast iron	33⅓
Flasks, snap steel	12½
Flasks, wood	Expense
Flasks, wood, snap, metal bound	20 to Expense
Forges	5
Furnace, annealing	10
Furnaces, crucible—pit	7½
Furnaces, cupola—steel	5
Furnaces, electric	5 to 7½
Furnaces, open-hearth	10
Furniture and fixtures, general	10
G	
Gages, steam recording	5
Gages, steam	10
Glassware, laboratory	Expense
Glue heaters	10
Generators, electric	5
Grinders, bench, for castings	7½
Grinders, hand air	20
Grinders, hand electric	20
Grinders, swing for castings	10
Grinders, tool	5
Guards, for machines, belts, etc	10
H	
Hangers, shaft	4
Heaters, boiler feed water	5
Heaters, foundry pot	10
Heating systems, hot air blower	6
Heating systems, steam	4
Hoists, air and hand	7½
Hoists, electric	10
Hoods, safety grinding wheel	5
Hose, air	Expense
Hose, fire	20
Hose, foundry	10
Hose, ladders, straps, etc	10
I	
Injectors, boiler	10
Instruments, engineering and drafting department	5
J	
Jackets for molds	Expense
Jacks, hand	10
Jacks, hydraulic	5
Jarring machines	10
K	
Kettles, cast iron	10
L	
Laboratory equipment, except glassware	7½
Laboratory equipment, glassware	Expense
Ladders, wood	Expense
Lanterns, fire	20
Lathes	5
Lavatories	5
Lightning arresters	10
Lockers, steel	5
M	
Machinery, general	5 to 10
Meters, electric	5
Meters, oil	7½
Meters, steam flow	10
Milling machines, according to kind	5 to 7½
Mixers, sand, Broughton type	10
Mixers, sand, Chile mill	7½
Molding machines, bench, Adams	7½
Molding machines, Berkshire	7½
Molding machines, rockover	5
Motors, electric	5
O	
Oil separators	5
Ovens, core, brick	10
Ovens, core, steel	10
Ovens, drying, brick	10
Ovens, drying, concrete	5
P	
Pans, steel tote	20
Patterns	10 to Expense
Pipe machine	5
Piping, air	5
Piping, fuel oil, overhead	5
Piping, fuel oil, underground	5 to 10
Piping, water and steam	5 to 7½
Planers, iron and wood	5
Plates, core	20 to Expense
Platforms for elevating trucks	Expense
Platforms, unloading	10
Plating machine, barrel	10
Pulleys, friction clutch	10
Pulleys, plain and split	5
Pumps, centrifugal water; if constantly used	20
Pump governors	5
Pumps, hydraulic	5
Pyrometers, thermoelectric	7½
Pumps, steam	5
NOTE:— Piping underground—life governed by use and character of protection.	
R	
Racks, iron core	5
Racks, iron for iron and steel storage	5
Racks, iron, tool and tray	5
Racks, revolving iron	10
Racks, wood	10
Regulators, feed water	5
Regulators, voltage	10
Riddles, sand, core shop	20
Rumblers, steel	7½
S	
Safety devices	10
Sand blast equipment	10
Sand mixer	See M
Saws, band, blades	Expense
Saws, band, machine	5
Saws, power	5
Scales, dormant	7½
Scales, platform	10
Sewers	2½
Shafting and hangers	4
Shapers	5
Shelving, steel	5
Shelving, wood	5 to 25
Signal boxes	7½
Sinks	10
Slip jackets and bands for molds	Expense
Sprinkler systems	3 to 7½
Sprue cutters	7½
Stacks, boiler and core ovens—steel	5 to 10
Stacks, brick	3
Stands, iron	5
Stands, wood	10
Steam separators	10
Steam traps	7½
Straightener for castings	10
Switch boards	4
T	
Tables, coremakers'	7½
Tables, wood, general	10
Tables, wood, iron covered	7½
Tanks, iron acid	15
Tanks, iron air and oil	5
Tanks, fire bucket	10 to 25
Tanks, water, cement	5
Tanks, water, iron	10
Tanks, wood	10 to 25
Testing machines, tensile	5
Tool, Stands	See S
Tools, small	4 to 50
Tractors, electric	10
Transformers, electric power	4
Trucks, barrel	25
Trucks, electric	10
Trucks, elevating	10
Trucks, iron frame, 4-wheel	10
Trucks, wood, hand	25
Trucks, wood, 4-wheel	12½
Tumbling barrels—(See rumblers)	7½
Turntables	10
V	
Valves, back pressure	5
Valves, reducing	7½
Valves, disk, brass	7½
Valves, gate, brass	5
Valves, gate, iron	10
Vises	10
W	
Welding apparatus, acetylene, generation	10
Welding apparatus, acetylene, tools	Expense
Welding apparatus, electric, generation	5
Wheel barrows	50
Wire cutters	10
Wire measuring machine	5
Wire straightener	5
Wiring and fixtures, lighting	7½ to 10

1—CURRENT ASSETS

(1-1)—*Cash in Bank:*

Debits—
(1) Open the account with the amount of cash in bank;
(2) Total amount of cash deposited during the month.

Balance—
Represents value of cash in bank at end of month. Should be reconciled with bank's statement to determine outstanding checks and uncredited deposits.

(1-2)—*Petty Cash:*

amount of cash on hand to cover petty expenses for a short period.

Credits—
(1) With any decrease in the amount on hand.

Balance—

Represents amount set aside for petty cash disbursements.

(1-3)—*Notes Receivable:*

Debits—
(1) Open the account with the face value of promissory notes and acceptances on hand;
(2) Notes and acceptances received;
(3) Notes renewed.

Credits—
(1) Payments on notes receivable and acceptances;
(2) All notes and acceptances sold or otherwise disposed of;
(3) All notes renewed.

Balance—
Represents value of all notes receivable and acceptances on hand.

(1-4)—*Accounts Receivable:*

Debits—
(1) Open the account with the total of individual customers' accounts in the accounts receivable ledger.
(2) The total charges to customers as represented by postings on sales register.

Credits—
(1) Total payments received from customers, whether cash, notes or acceptances.
(2) Allowances to customers, including cash discount; in other words, the gross settlements with customers.

Balance—
Represents the net amount due from customers.

(1-5)—*Bonds and Other Investments:*

Debits—
(1) Open the account with the market value of stocks and bonds on hand;
(2) Market value of other investments;
(3) Cash value of life insurance policies, etc.;
(4) Cost of all stock, bonds and other investments purchased.

Credits—
(1) Cost of stocks, bonds and other investments sold at value carried (profit or loss debits or credits profit and loss on investments).

Balance—
Represents cost value of stocks, bonds and other investments owned by the company.

2—INVENTORY ASSETS

(2-1)—*Melting Stock—Metals:*

(1) Open the account with the cost value of all melting stock or metals on hand;
(2) All purchases of melting stock metals;
(3) Transportation charges on incoming melting stock metals (distributable according to corresponding invoices);
(4) Unloading charges if a long term supply;
(5) Returns to stores of melting stock from melting department.

Credits—
(1) All withdrawals of melting stock metals as represented by monthly summary of metals used;
(2) All melting stock returned to vendors.

Balance—
Represents the value of melting stock metals on hand and should agree with the aggregate of the individual stock ledger sheets or cards.

Note:—The following subdivisions may be maintained:

1. Pig iron.
2. Purchased scrap.
3. Foundry scrap.
4. Ferromanganese.
5. Ferrosilicon.
6. Other melting stock as required.

(2-2)—*General Stores:*

Debits—
(1) Open the account with the value of all general stores material (i. e., other than melting stock metals) on hand;
(2) Purchases of additional material;
(3) Transportation charges on incoming general stores material (distributable according to corresponding invoices);
(4) Returns to stock general stores material.

Credits—
(1) Withdrawals of general stores material from stock as represented by monthly summary of materials used;
(2) Material returned to vendors.

Balance—
Represents the book value of general stores material on hand and should agree with the aggregate of the individual stock ledger sheets or cards.

(2-3)—*Finished Castings:*

Debits—
(1) Open the account with the physical value of all finished castings on hand;
(2) Deliveries of finished castings as represented by the summary of closed production orders—at cost;
(3) Returns of good material from customers.

Credits—
(1) Material shipped during the period as represented by summary of reports of shipments;

Balance—
Represents cost value of finished goods on hand.

(2-4)—*Work in Process:*

Debits—
(1) Open the account with cost of goods in process;
(2) With the total amount of molding productive labor and coremaking productive labor as represented by the summary of time cards on pay rolls;
(3) With cost of melt for the month at predetermined rate;
(4) With proper portion of following expense accounts at predetermined rates:
   a. Molding burden—direct labor,
   b. Molding burden—machine hour,
   c. Molding sand cost,
   d. Flask cost,
   e. Coremaking burden—direct labor,
   f. Coremaking burden—machine hour,
   g. Finishing cost,
   h. Annealing cost;
(5) With cost of castings returned by customers (if finished castings account not carried).

Credits—
(1) Cost of castings shipped, if finished castings account not carried, otherwise with cost of finished castings delivered to finished castings stores;
(2) Scrap value of bad castings and sprues returned to melting metals stock;
(3) Losses due to defective work or other errors in service distributable to the departmental expense involved.

Balance—
Represents cost of finished castings on hand and in process (if finished castings account not carried), otherwise of castings in process.

3— FIXED ASSETS

(3-1)—*Machinery and Equipment:*

(3-2)—*Real Estate and Buildings:*

Debits—
(1) Open accounts with the first cost or replacement value of all permanent plant investment represented by the respective accounts;
(2) All expenditures for permanent additions.

Credits—
(1) Value of fixed assets sold, disposed of or otherwise taken out of service.

Balance—
Represents book value of fixed assets against which as offsetting accounts are the respective reserves for depreciation.

4—DEFERRED ASSETS

(4-1)—*Prepaid Insurance:*

Debits—
(1) Open the account with the amount of unexpired insurance premiums;
(2) Subsequent insurance premiums.

Credits—
(1) Periodical charge equivalent to pro rata insurance cost for period;
(2) All refunds and cancellations.

Balance—
Represents unexpired insurance premiums.

(4-2)—*Prepaid Taxes* (*if prepaid—see* 6-4):

Debits—
(1) Open the account with total of unexpired taxes paid in advance;
(2) Subsequent taxes paid in advance.

Credits—
(1) Amount equivalent to one-twelfth the annual tax to effect liquidation of monthly charge to taxes in the various expense groups.

Balance—
Represents taxes paid in advance.

(4-3)—*Prepaid Interest* (*See* 6-6):

Debits—
(1) Open with balance of prepaid interest;
(2) All subsequent prepaid interest.

Credits—
(1) With monthly proportions of interest accrued as to the items entered in this account as prepaid.

Balance—
Inventory of unused prepaid interest.

5—INTANGIBLE ASSETS

(5-1)—*Patents:*

Debits—
(1) Open the account with the estimated value of patents owned;
(2) Cost of acquiring subsequent patents including all incidental expenses.

Credits—
(1) Pro rata amount equivalent to one-twelfth the annual charge for the extinguishment of patents. (If so treated.)

Balance—
Represents book value of patents owned.

(5-2)—*Good Will:*

Debits—
With value of good will.

Credits—
With any depreciation of same.

Balance—
Net value of good will as carried.

6—CURRENT LIABILITIES

(6-1)—*Notes Payable:*

Debits—
(1) Payments reducing the notes payable.

Credits—
(1) Open the account with the value of all outstanding notes payable;
(2) All subsequent notes issued.

Balance—
Represents amount owed by the company on notes payable.

(6-2)—*Accounts Payable:*

Debits—
(1) Payments of accounts payable;
(2) With all contra charges to vendors' accounts;
(3) Value of material returned to vendors for credit;
(4) With amount of notes given vendors;
(5) With all trade or cash discounts allowed by vendors and earned.

Credits—
(1) Open the account with the total of vendors' or purchase creditors' accounts;
(2) Total credits to accounts payable on the purchase journal.

Balance—
Represents net amount owed to creditors on open account.

(6-3)—*Accrued Pay Roll:*

Debits—
(1) Amount of wage and salary payments made during the period as represented by cash book entries;
(2) With amounts paid as bonus.

Credits—
(1) Amount of wages, salaries and bonus earned during the period.

Balance—
Represents pay roll amounts accrued but unpaid.

(6-4)—*Accrued Taxes (If accrued—See* 4-2):

Debits—
(1) Actual payment of taxes.

Credits—
(1) Monthly amount charged to operating expense.

Balance—
Represents accrued amount of taxes accumulated but not yet due.

(6-5)—*Accrued Commissions:*

Debits—
(1) Commissions actually paid agents or sales representatives.

Credits—
(1) All accrued commissions on sales billed (or orders taken) during the period, charging selling expenses.

Balance—
Represents commissions accrued but not paid.

(6-6)—*Accrued Interest* (*See* 4-3):

Debits—
(1) With interest paid as to items entered herein as accrued.

Credits—
(1) Open the account with the amount of accrued interest unpaid;
(2) With amounts accrued monthly on items where interest is accruing.

Balance—
Represents accrued interest on items payable accumulated but not yet paid.

7—FIXED LIABILITIES

(7-1)—*Bonds Payable:*

Debits—
(1) Payments reducing same.

Credits—
(1) Open with balance of all outstanding bonds;
(2) With all subsequent issues.

Balance—
Represents outstanding bonded indebtedness.

(7-2)—*Mortgages Payable:*

Debits—
(1) Payments reducing the principal of mortgages payable.

Credits—
(1) Open the account with the total amount due on the principal of all mortgages payable;
(2) Mortgages subsequently issued

Balance—
Represents total amount owing on mortgages payable.

8—RESERVES

(8-1)—*Reserve for Depreciation on Machinery and Equipment:*

(8-2)—*Reserve for Depreciation on Buildings:*

Debits—
(1) With that portion of the cost which has been depreciated of anything replaced or sold.

Credits—
(1) Open the account with the amount of reserve allowed for depreciation;
(2) Depreciation charge to departmental or general expenses equivalent to a pro rata amount of the annual depreciation charge.

Balance—
Represents the allowance for depreciation of permanent plant investments and maintained as offsetting accounts to the respective fixed asset accounts.

Note:—If the present net book value (first cost less depreciation amount) cannot be determined for any particular article replaced, the first cost should be credited to the fixed asset account and charged to the corresponding reserve for depreciation. If, however, the article replaced is sold or otherwise disposed of at a scrap value, the first cost should be credited to the fixed asset account and first cost less scrap or exchange value should be charged to the corresponding reserve for depreciation. The scrap value should, of course, be charged to the purchaser.

(8-3)—*Reserve for Bad Debts:*

Debits—
(1) With value of accounts receivable, considered uncollectable, crediting the individual customer's account so written off.

Credits—
(1) Open the account with an amount considered sufficient to cover all losses on accounts considered uncollectable;
(2) Amount based on a percentage of sales billed to provide for losses on amounts charged during the period.

Balance—
Represents allowance reserved for losses on accounts receivable.

9—CAPITAL LIABILITIES

(9-1)—*Capital Stock—Preferred Issued:*

(9-2)—*Capital Stock—Common Issued:*

Debits—
(1) With the par value of stock returned to or acquired by the company.

Credits—
(1) With the par value of stock outstanding.

Balance—
Represents the par value of issued capital stock outstanding, preferred and common, respectively.

10—SURPLUS AND PROFIT AND LOSS ACCOUNTS

(10-1)—*Surplus:*

Debits—
(1) With the amount of dividends at annual closing;
(2) With amount transferred from profit and loss (if loss) at annual closing period.

Credits—
(1) Open the account with the amount of undivided profits;
(2) With profits made during the current year transferred from profit and loss at annual closing.

Balance—
Represents undivided profits, if a credit.
Represents deficit, if a debit.

Note:—Make *no* entries to surplus account except at annual closing time.

(10-2)—*Income and Excess Profits Tax Account:*

Debits—
With amount of income and excess profits tax paid.

Credits—
With any necessary adjustments.

Balance—
Represents amount of income and excess profits taxes paid.

(10-3)—*Dividends—Preferred Stock:*

Debits—
(1) With the amount of dividend paid.

Credits—
(1) With debit to surplus at close of year.

Balance—
Represents dividends paid.

(10-4)—*Dividends—Common Stock:*

Debits—
(1) With the amount of dividends paid.

Credits—
(1) With debit to surplus at close of year.

Balance—
Represents dividends paid.

(10-5)—*Profit and Loss:*

At Annal Closing Time:

Debits—
(1) With debit balance of cost of castings sales;
(2) With debit balance of cost of miscellaneous sales;
(3) With debit balance of freight out on sales;
(4) With debit balance of administrative expenses;
(5) With debit balance of selling expenses;
(6) With debit balance of interest paid;
(7) With debit balance of discount given;
(8) With net amount of plant balances (operating expense accounts Nos. 12-1 to 12-18 inclusive) if such amounts are debit balances;
(9) With debit balance of adjustment.

At Annual Closing Time:

Credits—
(1) With credit balances of castings sales billed;
(2) With credit balance of miscellaneous sales;
(3) With credit balance of interest received;
(4) With credit balance of discount taken;
(5) With credit balance of interest on investments;
(6) With net amount of plant balances (operative expense accounts 12-1 to 12-18 inclusive) if such amounts are credit balances;
(7) With credit balances of adjustment account.

Balance—
Represents net profit or loss resulting from transactions of the period accumulated and should be transferred at end of the fiscal year to surplus.

(10-6)—*Adjustment Account:*

Debits—
(1) With any determinable decrease in any particular account not traceable to some other account;
(2) With necessary adjustments of any nature.

Credits—
(1) At closing periods with any determinable increase in any particular account not traceable to some other account;
(2) With necessary adjustments of any nature.

Balance—
Represents adjustments necessarily made.

(10-7)—*Castings Sales:*

Debits—
(1) With the billed amount of castings returned by customers;
(2) With allowances to customers as represented by credit memoranda if a sale reduction;
(3) With credit balance, transferring to profit and loss at annual closing time.

Credits—
(1) Total casting sales billed during the month as represented by the sales register, charging accounts receivable.

Balance—
Represents net sales billed.

(10-8)—*Cost of Casting Sales:*

Debits—
(1) Cost value of all material shipped as represented by summary of daily reports of shipments.

Credits—
(1) Cost of material returned by customers during the period;
(2) With the debit balance at the end of closing periods charging profit and loss.

Balance—
Represents net factory cost of shipments.

(10-9)—*Miscellaneous Sales:*

Debits—
(1) With value at sale price of any returned sales.

Credits—
(1) With sale value of any nature other than castings sales.

Balance—
Value of miscellaneous sales.

(10-10)—*Cost of Miscellaneous Sales:*

Debits—
(1) With cost of above sales.

Credits—
(1) With cost of any returned sales.

Balance—
Net cost of miscellaneous sales.

(10-11)—*Freight Out On Sales:*

Debits—
(1) With all payments of transportation of any nature for delivery of goods to customers.

Credits—
(1) With necessary adjustments.

Balance—
Net cost of delivering sales to customers.

(10-12)—*Administrative Expenses:*

Debits—
(1) With the aggregate of charges to all expense accounts classified as administrative expenses.

Credits—
(1) With debit balance at closing periods charging profit and loss.

Balance—
Represented aggregate of administrative expenses.

(10-13)—*Selling Expenses:*

Debit—
(1) With the aggregate of charges to all expense accounts classified as selling expenses.

Credits—
(1) With debit balance at closing periods charging profit and loss

Balance—
Represented aggregate of selling expenses.

11—FINANCIAL PROFIT AND LOSS ACCOUNTS

(11-1)—*Interest Received:*

Debits—
(1) With necessary adjustments.

Credits—
(1) With all interest received for balances or overdue accounts.

Balance—
Net interest received.

(11-2)—*Discount Taken:*

Debits—
(1) With credit balance, transferring to profit and loss.

Credits—
(1) With all cash discounts earned; does not include trade discounts.

Balance—
Represents cash discounts earned.

(11-3)—*Interest Paid:*

Debits—
(1) At closing periods with the amount of interest accrued for the month on items payable, crediting accrued interest or prepaid interest.

Credits—
(1) With debit balance, transferring to profit and loss.

Balance—
Represents amount of interest actually incurred.

Note:—If interest is prepaid, the payment should be charged to prepaid interest (Acct. 4-3). The amount should be liquidated in monthly amounts to apportion the charge equitably over the periods involved. Likewise, watch for action of accruing interest as explained in Account 6-6.

(11-4)—*Discount Given:*

Debits—
(1) Cash discounts allowed customers—does not include trade discounts.

Credits—
(1) With debit balance, transferring to profit and loss.

Balance—
Represents cash discounts allowed

(11-5)—*Interest or Dividends on Investments:*

Debits—
(1) With necessary adjustments.

Credits—
(1) With interest or dividends received on investments. This should be treated as separate from regular commercial interest.

Balance—
Net results of regular income outside investments.

12—OPERATING EXPENSES

Explanatory Note:

Accounts 12-1 to 12-18 inclusive cover the actual operating accounts; i. e., those that appear in the actual cost sheet, either by pound or percentage.

If reference is made to the skeleton statements, it will be noted that "Total to Date" is used, both in the body of the statement and in the comparative monthly statement.

It is quite evident, therefore, that if we should have but one account for each burden and cost statement, and credit this with the transfer at pre-

determined rates to work in process we would have no easy way of securing our "To date" figures.

In order to make this easy, we have two ledger accounts for each expense or burden account.

One bearing simply the name of the account, is for *debits only*, except where a credit is necessary to *adjust or correct the debits.*

The other, bearing the account name, followed by "Credits," is for *credits only* of the transfers to work in process, except when a debit may be necessary to *adjust or correct the credits.*

The result of this is that we have an accumulating figure for each kind of account which gives us from the general ledger trial balance the figures to use in our statements of "Total to Date" the monthly figures coming from our footings for the month's transactions, which *must* balance with the entries for the month in the ledger account controlling each expense account.

It is quickly seen, therefore, that the difference between the "debit" and "credit" account for each expense account is the over or under absorbed expense, and will and *must* agree with the monthly statements.

* * * * * *

Accounts 12-19 to 12-22 inclusive need but a single account as they are to be *entirely closed out* each month, being simply collective accounts as a medium to split down these expenses to the actual operating accounts.

* * * * * *

(12-1)—*Cost of Melt:*

Debits—
(1) Melting stock metals used (requisitions).
(1) Melting stock metals used (requisitions);
(2) Labor (time cards);
(3) Miscellaneous materials (requisitions);
(4) Charges direct from purchase register (expense ledger charge slips);
(5) Apportioned charges.

Credits—
(1) Adjustments of debits only.

(12-2)—*Cost of Melt—Credits:*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Value of metal poured at the standard predetermined rate.

(12-3)—*Molding Burden—Direct Labor:*

Debits—
(1) Labor (time cards);
(2) Materials (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges.

Credits—
(1) Adjustments of debits only.

(12-4)—*Molding Burden—Direct Labor—Credits:*

Debits—
(1) Adjustment of credits only.

Credits—
(1) Amount equal to molding direct labor x standard rate.

(12-5)—*Molding Burden—Machine Hour:*

Debits—
(1) Labor (time cards);
(2) Materials (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges of power and depreciation.

Credits—
(1) Adjustment of debits only.

(12-6)—*Molding Burden—Machine Hour—Credits:*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Amount equal to actual machine hours used x standard rate per hour.

(12-7)—*Molding Sand Cost (If used):*

Debits—
(1) Labor (time tickets);
(2) Materials (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips).

Credits—
(1) Adjustments of debits only.

(12-8)—*Molding Sand Cost—Credits (If used):*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Amount equal to total metal poured x standard rate per pound.

(12-9)—*Flask Cost (If Used):*

Debits—
(1) Labor (time tickets);
(2) Materials (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) With total monthly charges in pattern shop expense accounts Nos. 704 and 705 (by transfer).

Credits—
(1) Adjustments of debits only.

(12-10)—*Flask Cost—Credits (If used):*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Amount equal to total good castings x standard rate per pound.

(12-11)—*Coremaking Burden—Direct Labor:*

Debits—
(1) Labor (time tickets);
(2) Material (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges.

Credits—
(1) Adjustments of debits only.

(12-12)—*Coremaking Burden—Direct Labor—Credits:*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Amount equal to coremaking direct labor x standard rate.

(12-13)—*Coremaking Burden — Machine Hour:*

Debits—
(1) Labor (time tickets);
(2) Material (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges.

Credits—
(1) Adjustments of debits only.

(12-14)—*Coremaking Burden — Machine Hour—Credits:*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Amount equal to actual machine hours used x standard rate per hour.

(12-15)—*Finishing Cost:*

Debits—
(1) Labor (direct and indirect unless in large plants) (time tickets);
(2) Material (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges.

Credits—
(1) Adjustments of debits only.

(12-16)—*Finishing Costs—Credits:*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Amount equal to molding and core direct labor x standard rate.

(12-17)—*Annealing Cost:*

Debits—
(1) Labor (time tickets);
(2) Material (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges.

Credits—
(1) Adjustments of debits only.

(12-18)—*Annealing Cost—Credits:*

Debits—
(1) Adjustments of credits only.

Credits—
(1) Amount equal to total good castings x standard rate.

(12-19)—*Power, Light and Heat:*

Debits—
(1) Labor (time cards);
(2) Material (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges.

Credits—
(1) With total net balance at the close of each month distributed on a percentage or other basis to the various operating accounts as explained elsewhere.

Balance—
There should be no balance.

(12-20)—*Pattern Shop Expense:*

Debits—
(1) Labor (time tickets);
(2) Materials (requisitions);
(3) Charges direct from purchase journal (expense ledger charge slips);
(4) Apportioned charges.

Credits—
(1) With amount in order 702 charging molding burden—direct labor;
(2) With amount in order 703 charging coremaking burden—direct labor;
(3) With amounts in orders 704 and 705, charging flask cost.

(4) With amount of residue as directed.

Balance—

There should be no balance.

Note:—If pattern shop is operated as a producing department, and not solely as a co-operating department, the accounting shall be changed to correspond to the condition and provision made for:

1—Pattern production orders;
2—Pattern productive labor;
3—Pattern shop expense account;
4—Pattern work in process material and cost compilation changed accordingly.

(12-21)—*General Expense:*

Debits—

(1) Labor (time tickets);
(2) Material (requisitions);
(3) Charges direct from purchase journal (expense ledger debit slips);
(4) Apportioned charges.

Credits—

(1) With total net balance at end of each month distributed on the prescribed basis to each operating account.

Balance—

There should be no balance.

(12-22)—*Expense Ledger Account:*

Debits—

(1) At end of each month with total of charges made direct to operating accounts, which charges are represented by expense ledger charge slips.

Credits—

(1) With the total of expense ledger charge slips charging the various operating accounts.

Balance—

If any balance exists, it is in error, and the charge slips in the files for month should be checked back to the purchase journal.

13—SUNDRY GENERAL LEDGER ACCOUNTS

In this section of the ledger will be located all sundry accounts with firms and individuals, irrespective of whether their balance is debit or credit.

There are always a certain number of accounts that float around without any particular home, and this is the place to put all such.

When making up a statement, the accounts classify themselves according to their balance into two classes, i. e.:

General ledger accounts receivable;
General ledger accounts payable.

They will be so entered in the statements immediately under the accounts receivable, and accounts payable respectively.

Comments Regarding Starting Cost Work

While these comments are in numbered sequence, practically all may and should be handled at once.

First:—Get your house in order.

(a) Clean up your shop.

(b) See that a day's work goes through your entire shop in a day—that is—that each department is so tuned up with the others that there is a steady flow of work. Above all things, see that all work goes through and out of shop in sequence of the originating pouring of castings, *except* that you provide storage or accumulation points for the sorting and classifying of like castings in order to put them through finishing operations in lots.

(c) The foregoing is absolutely necessary; system or no system of costs, as it is only good business. But no system of costs or production follow up is worth a snap of a finger unless the plant is onto its job as to orderliness, and common everyday clean cut handling of its details.

Second:—Get your raw materials and supplies under proper storage control. If you have no stock room—build one. Why should you pay your good money for material—and then let anyone at all dip in to their hearts' content?

Third:—Get a clock for all employes to ring *in* and *out* on, so that you have some sound basis for timekeeping.

* * * * *

When you get squared away, with materials in stock rooms, and your pig iron, etc., in order, then start records.

Fourth:—It is most important to have a proper production order. Never mind what it is if you provide for telling your shop what and how many to make. While doing this, provide a method to record *what is made,* so that you know in each department just how your work is progressing. See how easy it is when your shop *keeps* it *going.*

Fifth:—Start time cards. Best to be 3″ x 5″ for easy filing. One job of one man for one day only to a time card. If possible, have your time recorded by timekeeper. Bad business depending on a laborer to be a record keeper; besides it's *cheaper* to *specialize* clerical work vs. mechanical.

Sixth:—Put into use the code of expense order shown herewith. You will delight in knowing where your money is going.

Seventh:—Let no material be used without a record. Requisitions 4″ x 6″ are best, as they fit a standard file—get an old crank for a storekeeper and he will pay his salary many times over in reduced material costs.

Eighth:—Provide a *real man* to handle your costs. One who understands the plant operations, and who understands the office end. *It will pay*—and pay well. Cost work is not a boy's job, and if made so had better be left alone.

* * * * *

Remember this. The finding of costs accomplishes two things:

First:—Tells you what you must charge for your goods to make a profit.

Second:—And perhaps the greater point of the two, it tells you just where your money goes—and if you go at it in a red-blooded way, you can make large cuts in your costs.

Forms? The least part of the game, except to have them the best for economical handling. The forms are the vehicles only of what you collect. The biggest thing is to *get behind it*—everyone pulling the same way, realizing that costs *must be known.*

Book Review

Graphic Production Control, by C. E. Knoeppel; cloth, 477 pages, 6 x 9; published by the Engineering Magazine Co., New York, and for sale by THE FOUNDRY. Price, $10 postpaid.

The basic principle that picturization conveys more to the average intelligence than do words or figures has formed the premise upon which Mr. Knoeppel has built a practical treatise of great value to the modern industrial world. Visualizing ideas is the theme, and the author has followed his own precepts faithfully in presenting his subject matter, both through the exceptional clearness of his writing and the free use of detailed suggestion to illustrate the points offered.

Mr. Knoeppel states that forms, figures and statistics depend for their intelligent use upon the preceptive faculty of the user. Therefore, he enhances preception and aids intelligence by picturing for his reader the essential data required in attacking industrial problems. The use of graphic charts almost to the entire exclusion of other methods of presenting figures, statistics, summaries and other essential information required in handling the armies during the war is touched upon as an example of simple, efficient management. The application of this war taught lesson to meet the imperative demands for more production during the reconstruction period is shown. The author then states the fundamental laws which underlie efficient management. He draws a minute outline of the analysis upon which graphite production is based. He impresses the need for efficient organization, as preliminary to graphic control and gives minutely and step by step the method for establishing the mechanism of his system.

Mr. Knoeppel's method has been in use in a number of large foundry, metal-working and machine shops, and also has been applied in the following manufacturing lines: Textile machinery, gas traction engines, steel plate construction, metal furniture, automobile axles and transmissions, small motors, taps, dies, hardware, clothing, rubber tires, oil producing and refining, and in automobile assembling plants.

Manufacturing Chilled Iron Car Wheels - VI

Procedure for Small Wheels Varies from Methods Already Described

BY H. E. DILLER

THUS far this series of articles has dealt almost exclusively with the manufacture of chilled iron wheels for railroad use. There are a great many purposes for which smaller wheels are used, and these require a somewhat different process of manufacture. There is more variation in size and design of the small wheels than of the standard car wheels, due to the great variety of uses to which the small wheel is put, as a number of instances will show. Few of the smaller wheels have double plates, a single plate being used for almost all of the small wheels which are not spoked. This plate frequently is reinforced with ribs of different design and many patterns are required for this type. Spoked wheels frequently have the spokes curved so that they may straighten and not break from the rim as the metal in the wheel sets and contracts, although some of the smaller wheels are made with straight spokes. One notable difference in the design of some small wheels from that of the standard wheel is in the hub which is made hollow to provide for oiling the axle bearing. In such wheels oil is put into the hollow hub from whence it is fed to the journal bearing, instead of being carried by cotton waste in the journal box as is the custom on railroad freight cars.

Probably the nearest approach to the standard wheel in size and weight is that used for street cars. This may be spoked or made with a solid body according to the desire of the designing engineer. The American Electric Railway association has no specification for chilled iron wheels and each manufacturer of street cars purchases according to his individual specifications. However, the chilled iron wheel does not have the prestige among builders of street cars that it possesses in the freight car industry and a smaller percentage of street cars are equipped with this type.

The smallest wheels made in large numbers with a chilled iron tread are those made for mine cars. These are produced under a great variety of conditions, two extremes being represented by the company which makes wheels for its own use and pays little attention to any requirements except that the wheels be free from cracks. The other is the foundry which makes wheels for the trade and is highly considerate of the reputation of its product.

An instance of the first class is a large steel company which required wheels for its own mine cars. The effort was made to produce these wheels, which were the spoked type, without annealing. A great many of the wheels broke when made from an iron which took a chill. Therefore, it was decided to try a softer metal. A mixture consisting mainly of broken ingot molds was tried and the resulting wheels were found to be free from cracked spokes. When the wheels were broken to examine their fracture it was found that the metal in the tread was close grained and dense, but was not white. These wheels are used without any anneal and give satisfactory service in the steel company. No record has been kept of the length of life of the wheels but the number of renewals indicates a reasonable long service. Only one large purchaser of mine car wheels buys to

FIG. 54—SMALL WHEELS ARE LOWERED INTO STEEL TANKS IMBEDDED IN THE FLOOR OF THE FOUNDRY IMMEDIATELY AFTER BEING CAST. WHEN THE ANNEAL IS FINISHED THE TANKS ARE LIFTED FROM THE PITS BY A CRANE—EACH TANK HOLDS ONE DAY'S CAST

specification. For this reason the manufacturer is bound only by his judgment as to the method of producing a wheel which will sustain his reputation at the lowest manufacturing cost.

That many of these manufacturers value the reputation of their product highly is illustrated by the number of them who go to the expense of adding as high as 25 per cent high-priced charcoal pig iron to the mixture. The reason for the use of charcoal iron as well as the subject of scrap iron in mine car wheels has been discussed when considering the metallurgy of railway, car-wheel iron.

The composition of mine car wheels is fairly well standardized, although the wheels are made by various small foundries which do not have an organization as do the manufacturers of the standard chilled iron car wheels. This may be due to the fact that one large user of mine car wheels issues a specification which many foundrymen believe to be the best practiced. However, no results of tests of wheels made to this specification have been published.

As might be expected, the silicon content of the small mine wheel is raised, and the iron mixture usually contains from 0.75 to 0.85 per cent silicon compared with 0.45 to 0.70 per cent in the standard wheels. Phosphorus is kept about the same in both classes of wheels, and ranges from 0.20 to 0.40 per cent. The upper limit seldom is reached in mine car wheels and some manufacturers keep the phosphorus below 0.30 as called for in the specifications where mentioned. The reverse is true in regard to manganese which, while keeping within the same limits in both classes of wheels, is kept nearer the upper figure in the mine car wheels and usually will come within the limits of 0.60 to 0.80 per cent.

Trouble Due to Sulphur

Practically all mine, car-wheel foundrymen agree that sulphur is detrimental to the iron and that the chill should be secured from using charcoal iron instead of from high sulphur content although the chill could be regulated by the silicon content. This is characterized by the expressions *sulphur chill* and *charcoal chill* used among mine car wheel manufacturers. The specifications which have been issued call for sulphur below 0.095 per cent and this may account for the general aversion to high sulphur iron held by the manufacturers of mine car wheels. Of course, if a foundry is accustomed to handling low sulphur iron trouble probably would be encountered if the amount of sulphur was raised before the foundryman became familiar with handling this grade. The objection that high sulphur in the iron makes the wheels red short and is apt to cause trouble when the wheel becomes overheated in braking would not hold as strongly for wheels running in the damp mines and braked with wood brakes as when the wheel is carrying cars which are gripped by a hard metallic brake for several miles at a time, as is the case with freight car wheels.

Foundries which make the standard wheels also sometimes cast smaller wheels. In such cases the order for small wheels usually is divided between several molders. This is done because it is considered that more skill is required to make the small wheel on account of variations from the regular standard practice with which the molders are familiar. It also requires greater effort from the molder and work on the standard wheel is preferred almost

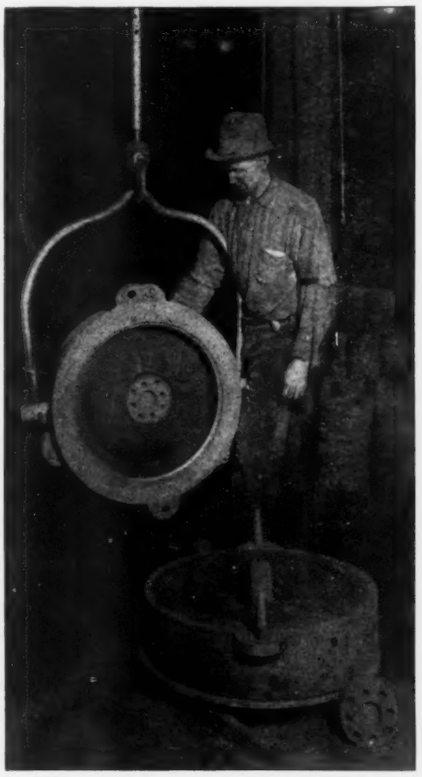


FIG. 57—THE MOLDER IN A SHOP TURNING OUT STANDARD CAR WHEELS DOES NOT LIKE TO MOLD SMALL WHEELS

universally. Fig. 57 shows a mold for a small wheel in a shop which makes standard wheels. Only part of the line is clear for small molds, and the molder is allowed to put up part of his day's work in standard molds. The wheel for which the mold has been made,

FIG. 55—THE MOLD FOR THE MINE CAR WHEEL OFTEN IS COMPLICATED BY A HUB

FIG. 56—FLASKS, PATTERNS, CORE AND CHILLER GIVE AN IDEA OF THE WORK REQUIRED TO MAKE A MINE-CAR WHEEL—NOTE THE HINGE ON THE FLASK

has spokes and a solid hub. Therefore, no ring core is required, but center and gate cores are sufficient. One of the gate cores may be noted in the center of the cope, and another lies beside the drag. Metal is poured through half of the holes shown. The other holes do not extend entirely through the core, but form lugs on the hub of the casting.

Few of the smaller foundries making mine car wheels have mechanical means for handling molds or carrying the design of flask used. Instead of having two dowel pins to locate the cope on the drag, a hinge and one dowel pin are used. The construction of the hinge may be noted in Fig. 56, which shows the equipment for making the mold. The hub core may be seen at *A*. This core is required by the design of the wheel which has a patented oiling system.

Annealing is carried on somewhat differently in the small wheel foundry. Care must be taken to get small wheels into the annealing pits as soon after they are cast as possible. The wheels are not piled evenly on each other but are thrown irregularly into large containers. The annealing equipment of one foundry is shown in Fig. 54. At the right is one of the tanks which are placed in pits in the ground and covered with steel tops. These covers have holes to which other smaller doors are fitted. When wheels are to be charged the smaller covers are removed and solid wheels, such as the one shown to the extreme left of the illustration, are dropped through the hole uninjured by the impact. Spoked wheels are let down on a hook until they rest on the pile of wheels in the tank. The wheels are allowed to cool in the tank under ground for three or four days. The tanks then are lifted by a crane and carried to the cleaning room. Here they are set on the floor, the clamps, one of which is shown at *A*, Fig. 46, are loosened. When a tank again is raised by the crane the wheels fall on the floor. The tank is carried back and after another bottom plate has been attached it is put back into the pit and is ready to receive more wheels. After the dumped wheels are somewhat cooled they are cleaned by tumbling.

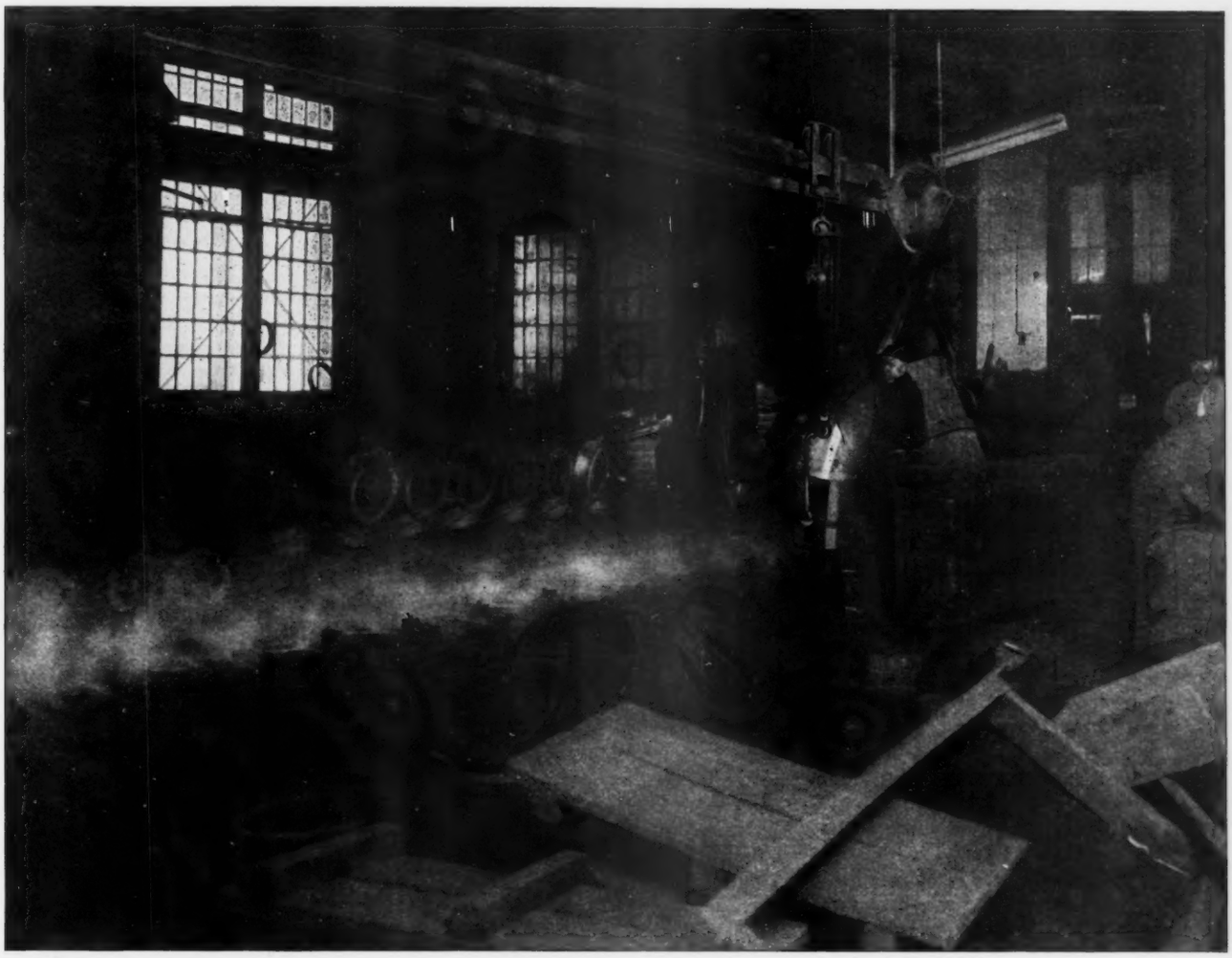


FIG. 58—FEW SMALL-WHEEL SHOPS HAVE A SYSTEM AS SHOWN HERE IN WHICH THE METAL IS CARRIED FROM THE CUPOLA TO THE POURING LADLE BY A CRANE—THE POURING LADLE TRAVELS ON AN OVERHEAD RUNWAY

metal. It is possible to get along in this way because of the smaller size of the molds, which can be handled by the molders. One of the foundries manufacturing car wheels is equipped with a monorail system for carrying the metal to the molds. A row of molds is set on either side of each monorail. The molds are poured from 1000-pound ladles which receive the metal from a mixing ladle into which it is tapped. The mixing ladle is carried to the molding floor by a traveling crane. Fig. 58 shows metal being transferred from the mixing ladle to the pouring ladle.

The mold shown in Fig. 55 illustrates

The United States civil service commission announces an open competitive examination for ordnance research engineer. A vacancy at the Frankford arsenal, Philadelphia, and vacancies in positions requiring similar qualifications, in the ordnance department at large or other branches of the service, at $4000 to $5000 a year, or higher or lower salaries, will be filled. Applications must be filed prior to June 22, 1920.

Cast Iron Made From Steel Turnings

The Process of Removing the Carbon From Cast Iron to Produce Steel is Reversed —Steel Turnings and Other Machine Shop Scrap Are Recarbonized to Produce Cast Iron

SYNTHETIC cast iron is the term by which, since the commencement of its manufacture in the electric furnace, the inventor of the process has always described the iron obtained by the recarburizing melting of steel turnings. This term has since passed into metallurgical currency, and has now become generic. The novelty of its manufacture consists in carburizing iron and steel scrap, more particularly turnings, by melting these materials in the presence of carbon, which is introduced simultaneously with them in the melting appliance. The electric furnace is plainly indicated as best fulfilling all the conditions required for the carrying out of this operation. Only a process of continuous carburization, effected during the course of melting a mixture of steel turnings and carbon could conduce to an economic method of producing synthetic cast iron with a commercial future capable of development. In an electric furnace charged with steel turnings mixed with carbon the carburization is not only absolutely controlled by the known reactions of the substances present, but it should be noted as an important economic advantage that the combination of the carbon with the iron begins in the upper parts of the charge long before actual fusion. Cementation intervenes from a temperature of 650 degrees upward and becomes more rapid in proportion as the temperature rises, owing to the descent of the charge.

Carburization of the iron takes place subsequently, by the contact between the solid carbon and the partially carburized metal in the course of melting, and becomes complete on full melting, the temperature of which is determined by the nature of the iron, so that casts can readily be obtained in the electric furnace at temperatures of 1200 degrees to 1300 degrees Cent.

The mixture of steel turnings and carbon possessing, in itself, very high conductivity, it would become necessary, to ensure normal working in the electric furnace, to use so low a potential that higher currents than those ordinarily in use could be employed. On the other hand, it would be a pity to employ electric fusion without profiting by the metallurgical advantages involved, in order to effect desulphurization. The introduction of basic slag into the charge meets these two requirements.

The iron obtained in the presence of a sufficiently basic slag, which combines with the small amount of silica introduced, will contain practically all the substances contained in the charge, except the sulphur. There will be no increase in the silicon, and the carbon in the charge will be used up solely in carburization, without any appreciable intervention of the silica. White cast iron can thus easily be obtained with ordinary steel turnings. With turnings containing 0.44 per cent of silicon, 0.55 per cent of manganese, and 0.07 per cent of sulphur a white iron of the following composition was obtained: Carbon, 3.55 per cent; silicon, 0.52 per cent; manganese, 0.48 per cent; sulphur, traces. Hence control of the percentages of silicon and of other elements becomes easy; for example, extra silicon will result from introducing more silica into the charge, along with a corresponding amount of carbon for reducing it. The percentage of silica in the slag will vary according to the percentage of silicon in the iron.

It will have been thoroughly understood from what has been said that control of the composition of the slag must be strictly exercised; also that the amount of carbon introduced must be accurately known. The process being one of great accuracy, is correspondingly highly sensitive. It is necessary therefore, to rely entirely on the help of the chemical laboratory.

The carbon employed for carburizing should correspond, so far as its physical condition is concerned with the size of the steel turnings, so that the contact between the particles may be as perfect as possible. Small coke is highly suitable, and so is wood charcoal. The system that has been described is one of extreme simplicity. It does not require any skilled workmen as the results sought are independent of any technical manipulation except in so far as the preparation of the charge is concerned, and depend entirely on an accurate knowledge of the composition of all the components. The electric furnace, fed continuously by the charge, works regularly and with very small losses, as the heat transmitted by the electric hearth situated immediately beneath the charge is, to a very large extent, utilized in heating up the materials and effects a preliminary carburization prior to melting. This enables the consumption of electrical energy to be reduced to as little as 675 kilowatt hours per ton of pig in a 2500-kilowatt furnace of 80 to 100 tons. Maintenance of a furnace, working in the manner described, is barely appreciable, seeing that with a six months campaign at Livet the above furnace did not require any repairs either to linings, shell or any other part.

The fundamental economic considerations in the manufacture of synthetic pig are as follows: (1) The electrode consumption can be lowered to as little as 13.6 pounds per ton, with electrodes of good quality. (2) The consumption of unoxidized turnings is 2310 pounds per ton (2240 pounds) of iron, a figure which, even with moderately rusty scrap, becomes only a little over 2400 pounds. (3) The amount of coke with 80 per cent fixed carbon required to produce a ton of strong pig iron with 3 per cent of carbon and 1.75 per cent of silicon, starting with normal turnings of shell

THE process of making synthetic cast iron; or the recarburization of steel scrap furnishes another evidence of metallurgical achievement made possible by the adoption of the electric furnace as a melting medium. Like many other processes and discoveries synthetic cast iron was brought into existence and developed during the war period because it was designed primarily for the production of semisteel shells.

The general economy of the process, combined with the simplicity of the method of carrying it out, makes it highly probable that while synthetic cast iron found a wide field of application during the war, owing to the large production of steel turnings derived from shell manufacture; it will find no less a field after the war in producing material with steel-like qualities required for mechanical parts.

Abstract from paper read before the Iron and Steel Institute. The author, Charles Albert Keller, Livet, France, is the inventor of the process.

THE FOUNDRY DATA SHEET, JUNE 15, 1920

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

USES OF IRON AND STEEL ETCHING SOLUTIONS

By Roy S. Kerns

Table Giving the Uses of Various Etching Solutions and the Structures Revealed by Each

CONSTITUENT	REAGENT	TIME	WASH	STRUCTURE	METHOD	REMARKS
General structure of iron and steel	Nitric acid and alcohol	10 sec.	Alcohol	Grain boundries	Immersion	
General structure of iron and steel	Picric acid and alcohol	30 sec.	Alcohol	Grain boundries	Immersion	Ferrite not attached
General structure of iron and steel	Concentrated nitric acid	1 sec.	Abundant water	Grain boundries	Immersion	Ferrite not attached
Cementite	Sodium picrate	5 to 10 min.	Alcohol	Cementite brown Ferrite unaffected	Immersion	Solution to be boiling
Phosphorus	Stead's reagent	60 sec.	Boiling water and methylated alcohol	Segregated spots and strips	Covered with a layer of reagent	Copper is deposited on the phosphorus
Phosphorus	Heat-tinting	Depending on color		Segregated spots and strips	Placed on surface	Yellow-brown to red and purple; or purple or blue on yellow-brown back ground
Ferrous Sulphide	Heat-tinting	Heat until brownish tint		Segregated spots and strips	Placed on surface	Purple
Manganese sulphide	Heat-tinting	Heat until brownish tint		Segregated spots and strips	Placed on surface	White
Sulphur	Printing with silk			Spots	Pressed on silk	Spots appear on silk
Sulphur	Printing with silver bromide paper			Stains, dark	Pressed on paper, moisten with dilute sulphuric acid	Appear dark on paper
Sulphur	Gelatin with acid solution of lead, mercury or cadmium			Stains yellow, of lead, mercury, or cadmium sulphides	Cover surface	
Wrought Iron	10% sol. of nitric acid and alcohol	10 to 15 sec.	Alcohol	Grains with slag inclusion dark	Immersion	
Wrought Iron	5% sol. of picric acid and alcohol	30 sec.	Alcohol	Grains with slag inclusion dark	Immersion	
Pearlite	Nital	8 to 10 sec.	Alcohol	Laminated strips of iron carbide and iron	Immersion	Iron white Iron carbide dark
Pearlite	Picric acid	20 sec.	Alcohol	Laminated strips of iron carbide and iron	Immersion	Ferrite or Cementite bright, pearlite dark

(Concluded on Data Sheet No. 338)

USES OF IRON AND STEEL ETCHING SOLUTIONS

By Roy S. Kerns

Table Giving the Uses of Various Etching Solutions and the Structures Revealed by Each

(Concluded from Data Sheet No. 337)

CONSTITUENT	REAGENT	TIME	WASH	STRUCTURE	METHOD	REMARKS
Sorbite	Nital	7 to 8 sec.	Alcohol	Granular	Immersion	Ill defined
Sorbite	Picric	15 sec.	Alcohol	Granular	Immersion	Ill defined
Troostite	Nital	2 to 3 sec.	Alcohol	Irregular and granular	Immersion	Darker than Martensite or Sorbite accompanying it
Troostite	Picric	5 sec.	Alcohol	Irregular and granular	Immersion	Darker than Martensite or Sorbite accompanying it
Martensite	Nital	5 sec.	Alcohol	Intersecting needles parallel to sides of triangle; zigzag lances and shafts with austenite	Immersion	Light color
Martensite	Picric acid	10 sec.	Alcohol			
Austentite	Nital	3 to 5 sec.	Alcohol	Polyhedra often worse much twinning in presence of Martensite		Bright
Austentite	Picric	5 to 6 sec.	Alcohol	Polyhedra often worse much twinning in presence of Martensite		Bright
Manganese	Nital	5 sec.	Water	Grains		Bright
High Speed Steel	Yatesevitch Reagent	10 to 12 sec.	Alcohol and water	Web structure of free cementite		Dark
Cast Iron	Common reagents	10 sec.	Alcohol	Grains and graphite strips in gray cast iron spots of carbon in malleable cast iron	Immersion	
Microstructure	Double chloride of copper and ammonia followed by 10% solution Nitric acid	3 min. 30 min.	Alcohol	Grains	Immersion	
Microstructure	Cupric ammonium chloride	2 min.	Water	Grains	Immersion	
Microstructure	20% nitric acid; hydrochloric acid dilute; sulphuric acid dilute	10 min.	Water	Grains	Immersion	

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

steel, is about 176 pounds. (4) A furnace of the 80 to 100-ton type should be provided with mechanical appliances for upkeep and charging, so that its operation does not require more than 15 workmen for the preparation, by hand, of the charge, for charging, and for regulating the furnace. (5) Tapping, and loading up on trucks as required, needs seven men per unit, and handling in the stockyard another two men.

The manufacture of malleable cast iron is likewise easily accomplished in the electric furnace, as the general quality of the steel turnings enables the low percentage of silicon and manganese required to be readily obtained, the reduced percentage of carbon present being dependent on the composition of the charge.

The metallurgical value of the results obtained by the process alter completely when it becomes a question of dephosphorization, which the author has practically accomplished by means of a dual process.

In the first place the steel turnings are melted in the presence of a small quantity of carbon and of a basic oxidizing slag. It is necessary to aim at a critical carburization which must be as high as possible, in order to lower the temperature of working and to facilitate the casting of the metal, while at the same time effecting dephosphorization. About 1 per cent of carbon or slightly more attains this object.

The first-stage dephosphorized metal, containing low percentages of silicon and manganese, is, according to circumstances, either cast into small ingots which are subsequently melted in an open furnace, mixed with the necessary additions of carbon and a desulphurizing slag composed of materials containing exceedingly little phosphorus, or else poured into a second furnace of the bricked-in type, and covered with a layer of anthracite for recarburizing. The synthetic cast iron produced is controlled in respect of its silicon and manganese percentages by the addition of oxides and of a corresponding amount of reducing carbon, in the ordinary way. This mode of working somewhat increases the cost of production during the first phase, and further necessitates, in the second phase, a converting cost equivalent to that of manufacturing ordinary synthetic cast iron. About 1500 kilowatt hours must be allowed for the two operations.

The author concludes this account of the chief metallurgical results obtained with synthetic cast iron by describing an alternative process which he has been led to contemplate in connection with the manufacture of steel from steel turnings.

As in the preceding example, the steel turnings are melted in an open furnace fed by the charge, but the slag, instead of being oxidizing, is desulphurizing, and the quantity of carbon introduced with the charge should be sufficient to reduce the oxides in the turnings and to carburize the metal to an extent distinctly above the percentage of carbon sought in the steel, so as to facilitate the pouring of desulphurized metal and to allow of an oxidizing working in the second stage of the operation.

For example, if a steel with 0.5 per cent of carbon be required, the metal in the primary furnace may be poured at 1.5 per cent of carbon. It will, as has been said, have been freed from sulphur during melting.

The secondary operation, which can be either in an open-hearth furnace or in an electric furnace, refines the metal and brings it to the required carburization, while at the same time dephosphorizing it. It then remains to bring the metal to the proper carbon content in the ordinary way.

The production of synthetic cast iron during the war has been considerable. It is not possible to estimate at the moment how much has been produced at works other than those administered by the Keller Leleux Co. at its works at Livet, Nanterre, and Limoges. The production of these three works alone exceeded 150,000 tons during the period of the war.

Directly after the specifications for projectiles of semisteel appeared, the author took steps to produce a metal complying with the conditions laid down by the French ordnance department. By November, 1914, such an iron had been produced and investigated, corresponding with the following composition: Carbon, 2.9 per cent; silicon, 1.75 per cent; manganese, 0.50 per cent; sulphur, traces; phosphorus, 0.05 per cent. The tensile strength of this iron was as high as 71,000 pounds per square inch in some cases, exceeding ordnance department specifications by 35,500 pounds.

Costs Show Further Increase

FOUNDRYMEN who have been forced to advance the price of castings to an unprecedented level, under pressure of advancing costs, owe it to themselves, their customers and their employes to present the basis for such action. With this thought, the Thomas Devlin Mfg. Co., Philadelphia, which produces malleable, gray iron, brass and steel castings, has prepared an analysis which shows an increase over last February. The labor cost over a period of years is taken as a foundation upon which to establish the percentage of increase in cost. Five groups or classifications are studied and compared, to arrive at the percentage of increase between 1909 and 1920. This is secured in the manner indicated in the accompanying table.

	1909	Molders received	$18.00 per week	60 hrs.	= $ .30	per hr.		
May 1,	1920	Molders (Day)	48.00 per week	48 hrs.	= 1.00	per hr.	advance of	233%
		Molders (Piece)	56.28 per week	48 hrs.	= 1.17	per hr.	advance of	290%
	1909	Machinists	18.00 per week	60 hrs.	= .30	per hr.		
May 1,	1920	Machinists	38.00 per week	48 hrs.	= .79⅛	per hr.	advance of	164%
	1909	Tool Makers	18.00 per week	60 hrs.	= .30	per hr.		
May 1,	1920	Tool Makers	43.00 per week	48 hrs.	= .8956	per hr.	advance of	200%
	1909	Laborers	9.00 per week	60 hrs.	= .15	per hr.		
May 1,	1920	Laborers	25.00 per week	48 hrs.	= .52	per hr.	advance of	246%

1133

1133 per cent, the sum of the increases, divided by 5 gives an average advance of 226 per cent.

In 1909 this company sold castings at 6 cents per pound. The materials used cost a fraction less than 1 cent per pound, and deducting a profit of 10 per cent, there was left a balance of about 4½ cents to pay for molding, melting, cleaning, finishing, assorting, and all overhead expenses.

Utilizing the percentage figure obtained as previously shown, the company estimates its new selling price in the following manner:

226 per cent x 4½c =
$0.1017 increased cost of labor.
0.0540 cost with 10% profit off 1909 price of 6c.
0.0200 increased cost of iron since 1909.
0.0015 increased cost of superintendence.
0.0172 profit of 10 per cent.

$0.1944 selling price 1920.

Therefore, the company now must charge its customers 19.44 cents per pound instead of 6 cents in order to cover the actual increase in cost of labor and materials. This figure does not include war taxes and other items which have increased in proportion.

It is explained that iron, coal, coke and other raw materials have advanced from 100 to 200 per cent, and that new taxes, other items unknown in 1909 have entered to increase this total. The company has issued a form letter setting forth the facts as stated.

Electrical Melting of Alloys---VIII

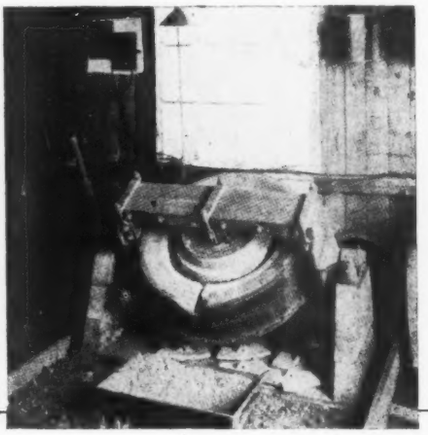
Induction Type Furnaces Offer Advantages in Melting Certain Alloys, But Possess Limitations Which Prevent Their Use for High Lead or Copper Alloys

BY H. W. GILLETT

IT HAS been shown that volatility of zinc is the factor that makes the common types of electric steel furnace inapplicable to brass. Therefore, the development of the rocking indirect arc type and the granular resistor, reflected heat type, both specially designed for brass, was necessary to cover the nonferrous field. There is another electric furnace, specially designed for brass, which departs far more from the beaten track of steel furnaces, and is highly successful in its own special field. This is an induction furnace, the Ajax-Wyatt*, made by the Ajax Metal Co., Philadelphia.

It has been pointed out repeatedly that the nearer the approach to internal heating in an electric furnace and the more compact the furnace, the less waste space it contains and the less the wall area, the more efficient it is. The Ajax-Northrup, as has been stated in the article on crucible furnaces, attains this idea, but does it only by the use of high-frequency current, which not yet is commercially available at reasonable cost. The Ajax-Wyatt approaches this idea closely, and uses ordinary alternating current. Internal heating is attained by the use of the metal itself as the resistor, making it the secondary of a transformer, in an induction furnace. Ordinary, or horizontal ring induction furnaces long have been known and have been used for melting steel, but they consist of a maximum of wall and a minimum of hearth capacity, and hence are inefficient through thermal leakage even though they generate heat in the metal itself. Their use still persists in Germany, but they have almost vanished from American steel melting practice. The simplest form is shown in Fig. 1 and its construction, on the principle of a transformer with one turn on the secondary, is shown in Fig. 2.

Such a furnace will not operate on brass, though it will on steel, because the resistance of brass is so much the lower that, at a power input sufficient to melt brass, the voltage is low and the current high. The current, in trying to melt brass, bronze, copper, aluminum, etc., has to be so high that a phenomenon called the *pinch effect* occurs and prevents the operation of the furnace. On nickel and some of its alloys, the resistance is high enough so that the behavior is like that on steel, and a furnace much like that in Fig. 1 was used regularly, in 1919, and still is in use by the Hoskins Mfg. Co., on nickel, though it probably will be superceded ultimately by a direct arc furnace.



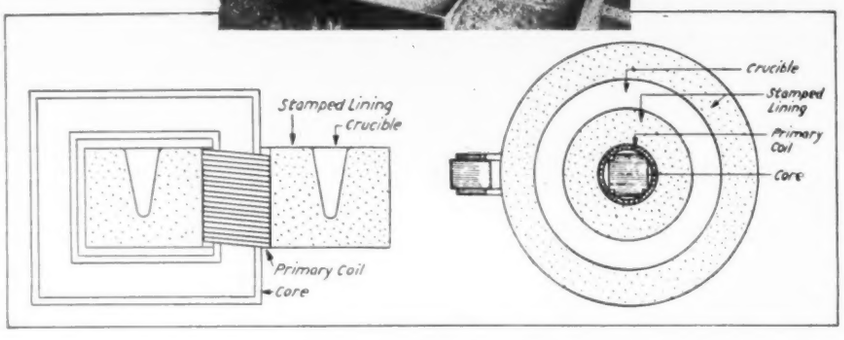


FIG. 1—HORIZONTAL RING FORM OF SMALL INDUCTION FURNACE, TILTED TO SHOW POURING POSITION. FIG. 2—VERTICAL AND HORIZONTAL CROSS SECTIONS OF SINGLE RING INDUCTION FURNACE

When current is passed through a conductor, the conductor tends to contract. Solid conductors cannot contract, but those which are liquid can. This contraction increases with the square of the current, and at the high currents required in an induction furnace working on nonferrous alloys, the ring of molten metal in the secondary is actually *pinched* off, so that there is no contact between the pinched-off ends and therefore no more current flows. The ring has to be forcibly held together in order to continue heating, and it cannot be forced to stay together in an induction furnace with a horizontal ring open at the top.

By closing the top of the secondary ring so that the metal is confined, by placing it vertical instead of horizontal, and by providing a reservoir at the top of the ring, the hydraulic head of molten metal in the reservoir can be made to exert enough pressure to counteract the pinch force, hold the metal together in the secondary, and thus allow heating to proceed.

When the metal in the secondary is thus confined, the pinch force cannot separate the metal, but it can move it. It sets up a strong circulation, which makes it possible to heat a much larger mass of metal than can be held in the secondary ring itself. The automatic circulation, which draws molten, but cool, metal into the ring, heats it and pumps it out. It will be seen that this circulation insures thorough mixing of the charge.

In the simplest form of the vertical ring induction furnace the metal within the furnace has the shape of a signet ring with the signet, representing the hearth, held uppermost. The loop of the ring then represents the secondary loop.

As the induction furnace is a trans-

Wyatt, J. R., U. S. Patents, 1201671—1235628—1235629—1235630—1312069—1313571 (The furnace is also licensed under the following U. S. patents:
Schneider, U. S. Patents 761920—763330.
Kjellin, F. A., U. S. Patent 682088.
Hering, C., U. S. Patent 988936.)

Clamer, G. H., Melting Brass in the Induction Furnace, Jour., Am. Inst. Metals, Vol. 11, 1917, p. 385.

Clamer, G. H., Ajax-Wyatt Electric Furnace, Metal Ind., Vol. 17, 1919, p. 362.

Blakeslee, R. N., Jr., Operating Brass-Making Induction Furnaces, Electrical World, Vol. 74, 1919, p. 642.

Kenyon, O. A., Developments in Brass Melting, Iron Age, Vol. 105, 1920, pp. 810, 880, Brass World, Vol. 16, 1920, p. 87.

former with a molten secondary, and has the usual transformer core within the secondary loop, care must be taken, just as in a transformer, to avoid magnetic leakage. Hence, instead of the secondary loop having a circular cross section, it is flattened out into a loop, of a rectangular cross section, the better to enclose the core. By this means the power factor can be brought up to a better figure than in a horizontal ring-type furnace, which does not allow as effective prevention of magnetic leakage. Foley* has worked with furnaces of this type at the Bristol Brass Co., Bristol, Conn., but, according to recent advices from that firm, the Foley furnace is not yet on a commercial basis, so only the Ajax-Wyatt, which is, will be considered here.

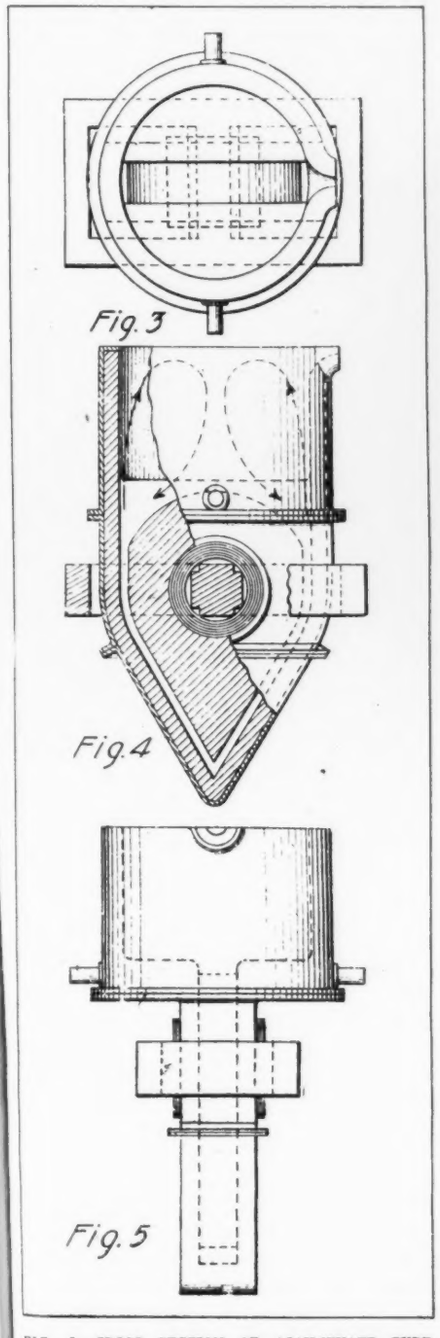


FIG. 3—CROSS SECTION OF AJAX-WYATT TYPE FURNACE FIG. 4—SECTION WITH ARROWS SHOWING THE CIRCULATION OF MOLTEN METAL FIG. 5—ELEVATION OF AJAX-WYATT FURNACE

Use Angular Loop

In the Ajax-Wyatt, instead of the secondary loop being in circular or semi-circular shape, it is in the shape of a *V*, with the hearth making the connection across the top. By having this acute angle in the loop, electromagnetic repulsion at the vertex sets up a still greater circulation, due to what is termed the *motor effect*. Therefore, the design of the Ajax-Wyatt becomes as is shown in Figs. 3, 4 and 5. The arrows in Fig. 4 show the circulation of the metal. Figs. 6 and 7 show the first furnace to be built in a commercial size, operating at the Ajax Metal Co. plant on ingot and slab metal in January, 1916.

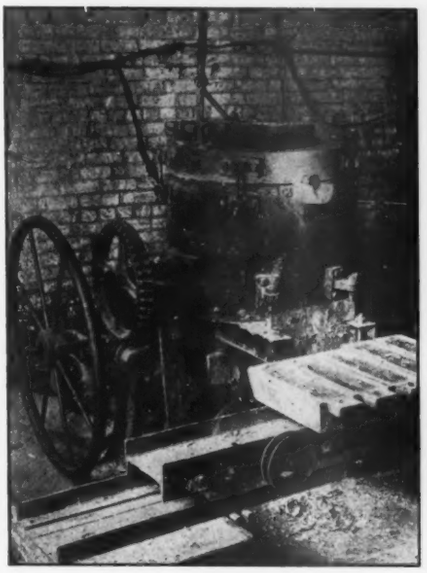


FIG. 6—FIRST COMMERCIAL SIZE INDUCTION FURNACE

The furnace shown, the writer believes, was the first electric brass furnace in America that melted metal for commercial purposes and was of a type that continued in commercial use. Figs 8 and 9 show the most modern styles. The Bridgeport Brass Co. has modified the furnace somewhat, placing a special door in the back of the furnace for skimming and charging just above the metal level, the body of the furnace being somewhat taller than in the usual Ajax form.

This furnace did not come into being in a jiffy. It was preceded by a vast amount of work by the Ajax Metal Co. on the Hering furnace. Hering, who had discovered the pinch effect, set to work to utilize it in a furnace. By passing current through molten metal in tubes, holes in the refractory, below a hearth, he opposed the pinch force by a hydraulic head and obtained circulation. However, a solid electrode has to be used to carry current to the resistor tube. In the largest furnace built, shown in Figs. 10 and 11, each resistor tube ran at about 3 volts and 11,000 amperes. To carry such a current in solid electrodes, the electrodes had to be made of copper and water-cooled to keep them solid. To reduce losses in the leads, the transformer had to be fastened directly into the bottom of the furnace. There are great difficulties in the design of a suitable transformer which will do the work and yield satisfactory results on electric furnaces designed to be operated on any type of nonferrous metal.

FIG. 7—SIDE VIEW SHOWING CONTROL PANEL OF SAME FURNACE

Hering furnaces were thoroughly tried out by the Ajax Metal Co.,** the Scovill Mfg. Co. and the National Cash Register Co. in 1914-1915. They gave low metal losses, as nearly half the power supplied never reached the resistor tubes. The power consumption was excessive due to the heat expended in the transformer and in the great

*Foley, C. B., British Patent, 114853 of 1916.

**Hering, C. A., Practical Limitation of Resistance Furnaces, the "Pinch" Phenomenon, Trans. Am. Electrochem. Soc., Vol. 11, 1907, p. 329.
The Working Limit in Electrical Furnaces due to the "Pinch" Phenomenon, Trans. Am. Electrochem. Soc., Vol. 15, 1909, p. 255.
Fitzgerald, F. A. J., Discussion, Trans. Am. Electrochem. Soc., Vol. 15, 1909, p. 278.
Hering, C., U. S. Patents 988936, 999720, 1105656.
Hering, C., A New Type of Electric Furnace, Trans. Am. Electrochem. Soc., Vol. 19, 1911, p. 255.
Electric Furnace for Molten Materials, Met. and Chem. Eng., Vol. 9, 1911, p. 371.
Ideals and Limitations in the Melting of Nonferrous Metals, Jour. Inst. Metals (British) Vol. 17, 1917, p. 243.
Advantages of a Small High-Speed Electric Furnace, Met. and Chem. Eng., Vol. 11, 1913, p. 183.
Clamer, G. H., The Hering Electric Furnace for Commercial Brass Melting, Trans. Am. Inst. Metals, Vol. 7, 1913, p. 350.
Clamer, G. H., and Hering, C., Electric Brass Melting, Trans. Am. Inst. Metals, Vol. 8, 1914, p. 270.
Clamer, G. H., and Hering, C., The Electric Furnace for Brass Melting, Vol. 6, 1912, p. 95.

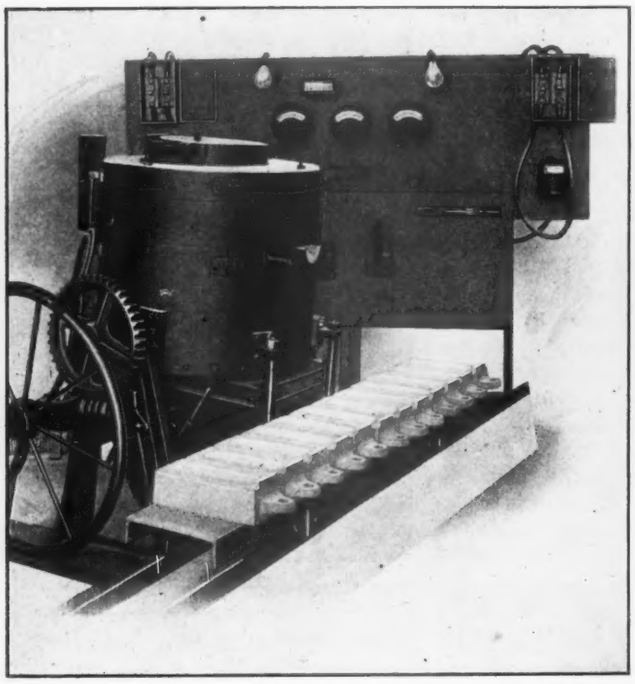


FIG. 8—TRUNNION TYPE AJAX-WYATT FURNACE OF 60 KILOWATT RATING

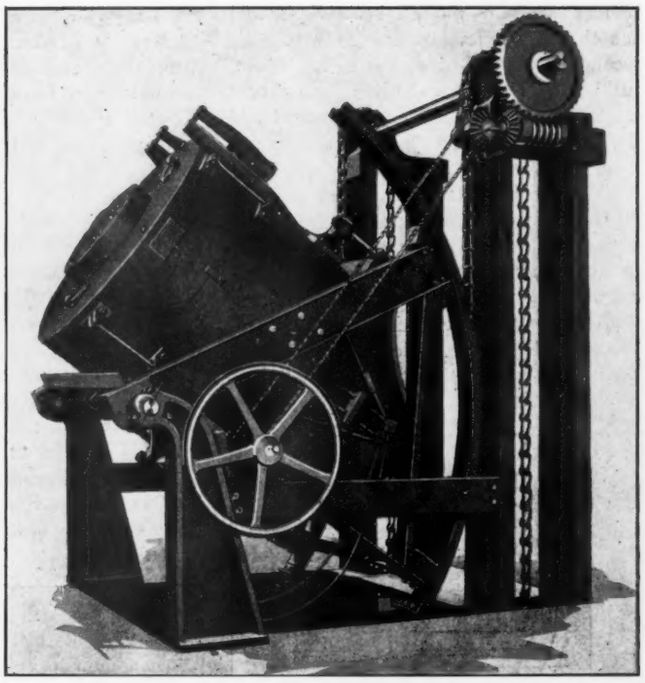


FIG. 9—NOSE TILTING TYPE ADAPTED TO POURING INGOTS DIRECTLY

amount of cooling water it was necessary to use to keep the copper electrodes solid and to prevent their melting back to the water and causing an explosion. On four tons of manganese bronze, containing about 40 per cent zinc, melted in a 100 kilowatt furnace, pouring 625 pounds per heat, heated to 1010 degrees Cent., in 21 1-3 hours, continuous operation, the furnace being fully hot at the start, the power consumption was about 400 kilowatt hours per ton.

After the Hering furnace had been reluctantly discarded, the Ajax Metal Co. eliminated the electrodes, joined two resistor tubes together into the secondary of an induction furnace, and thereby avoided, in the Ajax-Wyatt, the electrode and transformer troubles of the Hering.

The Ajax-Wyatt furnace consists of a cylindrical chamber into the bottom of which open the two legs of the V-shaped resistor, or secondary, loop. The laminated iron transformer core is a three-legged type. The central leg, on which the primary coil is wound, is within the resistor loop. The primary coil and the transformer are enclosed in a casing and cooled by a blast of air from a small blower.

The furnace was first made in a 30 kilowatt size, pouring about 300 pounds per heat, but the standard size is now 60 kilowatt pouring about 600 pounds per heat. They take 220 volt, single phase power and, on a 60 cycle line, have a power factor of 81 for the 60 kilowatt and 87 for the 30 kilowatt, a highly satisfactory figure for an induction furnace.

Since the heat is generated in the metal itself the furnace does not have to be insulated against temperatures above the pouring temperature of the alloy melted. An excessively thick lining therefore is not required. The furnace is extremely compact and takes little floor space when its output is considered.

The furnace is lined with high temperature asbestos cement, which must be uniformly mixed and tightly rammed. Experiments with refractories on the order of crucible mixtures, with which it is hoped to be able to handle highly leaded alloys, are under way. The resistor loop is initially formed by ramming up the lining about a brass casting which is left in.

After slow and careful air and overdrying, to drive out moisture and set the cement, the hearth is heated by the flame from a gas torch, molten zinc poured in and power applied, at a low voltage. When the brass casting has heated, alloyed with the zinc and melted, full power is applied, brass scrap and copper are added to bring the metallic contents to the proper composition, and the furnace is then in action. When the furnace is shut down, all the metal is drained from the resistor, since, if it is allowed to freeze

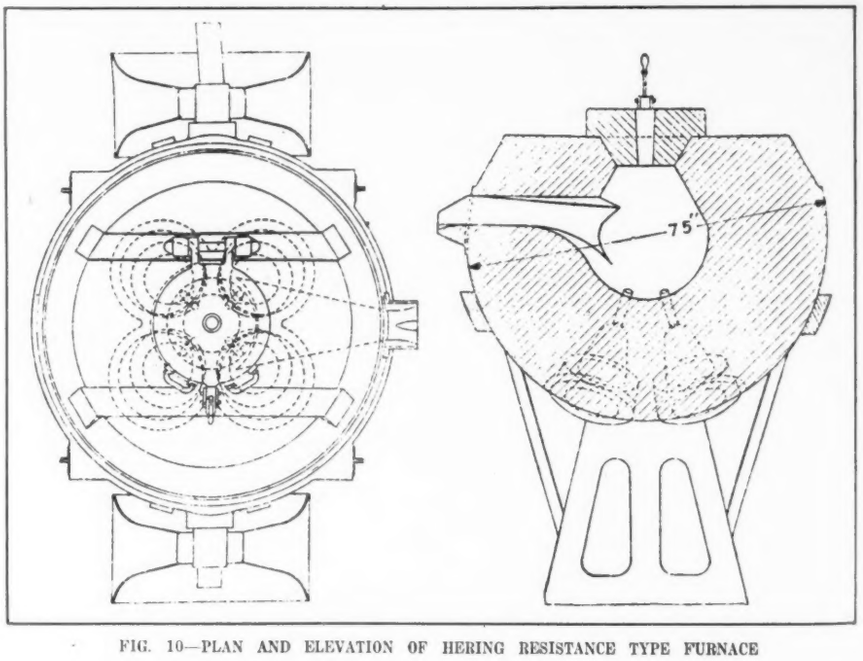


FIG. 10—PLAN AND ELEVATION OF HERING RESISTANCE TYPE FURNACE

in it, the lining will be cracked and ruined. In starting after a shut-down, the furnace is warmed by a gas flame, molten zinc is poured into the resistor, and scrap brass is fed in as in the original start.

If suitable precautions are taken in lining, drying, and operating the furnace, good lining life is obtained. The 300-pound size runs from 75 tons to an average of 250 tons, and sometimes gives as high as 375 tons at the Bridgeport Brass Co., and the 600-pound size at the American Brass Co. averages 400 to 600 tons on 60/40 or 70/30 brass, with some linings lasting for over 750 tons. The lining stands up less well against alloys high in lead, but the American Hardware Co., melting an alloy with 30 per cent zinc, and 5 per cent lead, averaged about 60 tons per lining in the 300-pound size.

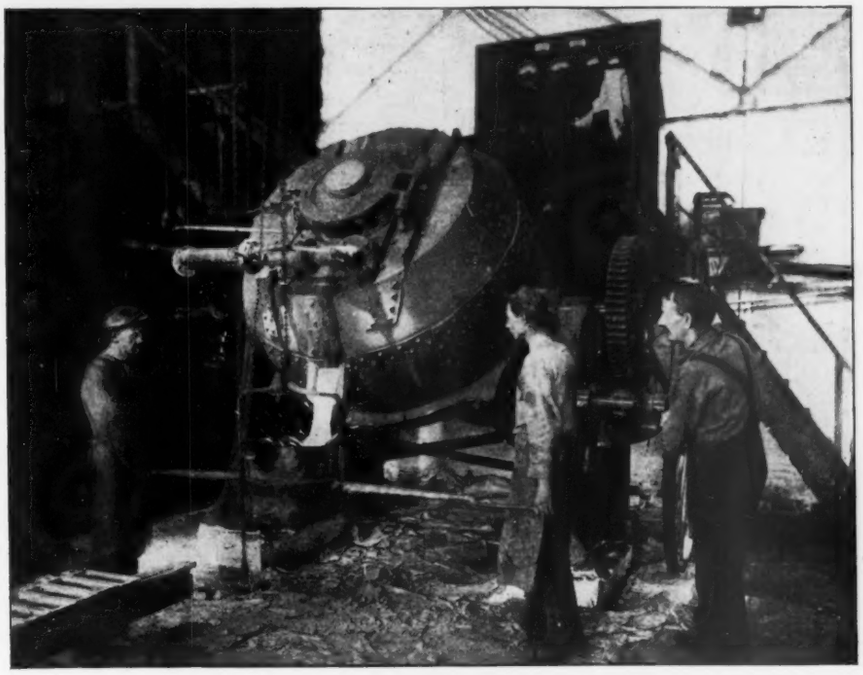


FIG. 11—HERING FURNACE IN OPERATION—NOTE THE PIPING NECESSARY TO WATER COOL THE ELECTRODES

The makers in the past have not advocated the furnace for alloys of over 3 to 3½ per cent lead but now state that it will handle up to 6 per cent lead, though detailed performance figures on such alloys are not available.

Leaks Are Detrimental

Cracks in the lining of the resistor tube that allow metal to seep through and reach the casing so as to short circuit the secondary through the casing, are fatal, and lead will ooze out through a hair crack that other metals would not pass. The relining cost for the 60 kilowatt is given by the makers as $200 under 1920 prices.

The furnace operation is simple, the simplest, in fact, of any electric furnace. When the switch is closed, the furnace at once operates at its full load and continues to operate steadily and with almost no variation, save the slight change due to difference in resistance of the metal in the loop at different temperatures. There are no surges. Temperature control is absolute. There is no heat storage at temperatures above that of the charge, so there is instant response in temperature to the throwing the power on or off.

If the heating is allowed to continue so far that the metal in the secondary loop reaches the actual boiling point of zinc in the alloy, bubbles of zinc vapor form in the tube, this alters the resistance of the secondary, and the ammeter needle starts to kick. This means that all the metal the furnace has to work on is heated up. It occurs only when a charge of scrap has bridged over in the furnace chamber and needs poking down, or when the metal has been allowed to get slightly hotter than it should be before pouring.

The metal losses are low. The Bridgeport Brass Co. gives its average net loss on yellow brass as 0.50 per cent. Charges of all yellow borings that gave a net loss of 5 per cent in crucibles, gave, in a week's run in an Ajax-Wyatt one of 2.7 per cent.

There is no automatically reducing atmosphere in this furnace as there is in the other types, for there are no carbon parts in the furnace. Therefore, it is desirable to keep a layer of charcoal over the metal to prevent oxidation, though this is not always done as zinc vapor is heavier than air, lies in the furnace chamber and excludes air to some extent. A layer of zinc oxide builds up about the upper part of the hearth and has to be chipped out with a high-speed tool steel pneumatic chisel every two or three days to keep the accretion from cutting down the hearth capacity. The quality of the metal is excellent. The rolling mills pour directly into the molds. There is a special nose-tilting type for this, and the trunion type also is used, either by moving the mold so as to follow the spout or by picking the furnace up with a crane and pouring it like a ladle.

The Bridgeport Brass Co. obtains better shrinking, less crop, less scrap, better surface and more uniform metal from this type furnace. This firm has torn down its stacks and gone definitely and wholly over to electric melting. It advertises this fact and also has offered its reserve stock of crucibles for sale. In its advertisements it states that electric melting is the greatest advance in the brass industry for 140 years. Since going to electric melting it has had no cases of brass shakes, and fewer severe burns.

Mixing is Thorough

The thorough mixing of the charge by the circulation of metal in this furnace is one of its greatest advantages. The American Brass Co. states that in its 600-pound furnaces, 100 pounds of zinc is mixed in with absolute thoroughness in five minutes with no stirring other than that done by the furnace itself. Analyses from top, middle and bottom of ingots from the Ajax-Wyatt often reveal no difference outside the limits of analytical error.

Out of 52 heats on an alloy of 62 per cent copper, 38 per cent zinc, the difference in copper content between top and bottom was within 0.20 per cent on 19, and within 0.50 per cent on 46. Outside of two heats which showed a variation of slightly over 1 per cent, all the heats came within 0.75 per cent copper.

The thermal efficiency of the furnace is the highest shown by any type of electric brass furnace. The production is not high because of the small size and low power, but this is not a real drawback because the compactness of the furnace and its ease of control will allow the installation of a battery of three or four furnaces in the space occupied by a 1500 or 2000-pound furnace of other types, and their operation by as few men. The furnaces are small but they are not toys.

In average 24-hour operation of the 300-pound furnace at the Bridgeport Brass Co. on 70/30 or 60/40 brass, the output is a little under three tons per furnace per day at 250 kilowatt hours

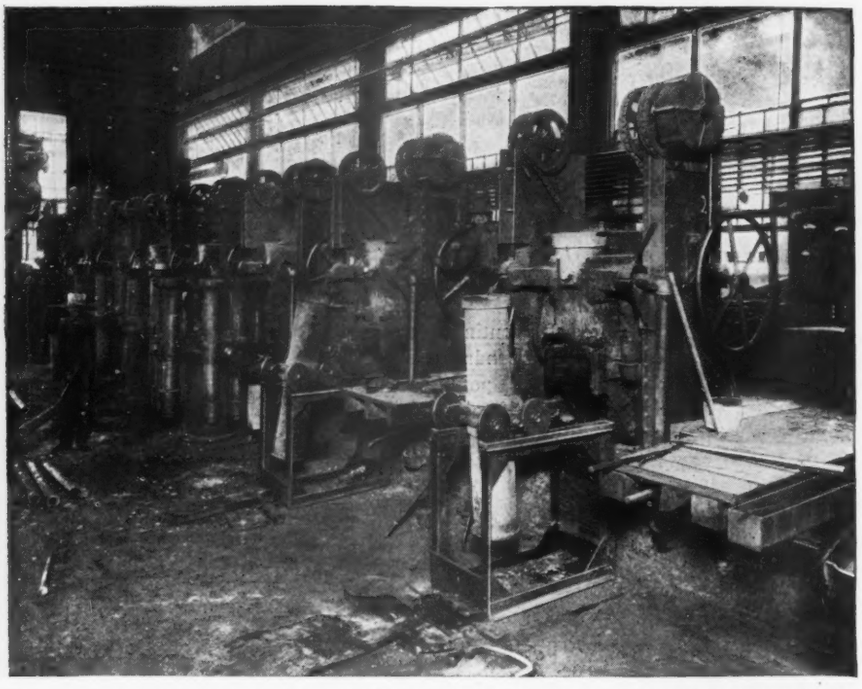


FIG. 12—POURING SIDE OF A BATTERY OF INDUCTION FURNACES AT THE BRIDGEPORT BRASS CO. PLANT

per ton. At the American Hardware Co., the power consumption was 245 kilowatt hours per ton. Under test conditions, the output can be raised to more than three tons and the power consumption dropped to less than 210 kilowatt hours per ton.

In the 600-pound furnace, on yellow brass, the American Brass Co. on 24-hour operation under most favorable conditions, gets a power consumption of less than 175 kilowatt hours per ton, which would correspond to 200-220 kilowatt hours per ton in average operation, and to outputs of 6 to 7½ tons per furnace per day. Few other furnaces approach so good a power consumption. As with every other electric furnace, operation on charges of all oily yellow borings can be made only at a poorer power consumption figure, a decreased output, and greater attention than on clean, solid metal.

Application Limited

The furnace has every advantage an electric furnace can have with the exception of versatility. It probably is unexcelled for operation on yellow brass 24 hours per day. It can handle alloys with only about 10 per cent zinc, as the resistance of molten alloys from 10 to 40 per cent zinc is not greatly different, and an auto-transformer in the primary will give the needed difference in voltage. Alloys approaching pure copper would need a resistor of different cross-section, and the power factor would not be so good.

This limitation, coupled with that due to the yet unsolved problem of refractories suitable for handling alloys high in lead, makes the furnace incapable of handling all the alloys of the average jobbing shop, and less applicable to red brass or bronze than to yellow. Another limitation lies in the fact that only the contents of the hearth are poured, as the metal in the loop and enough more to make contact between the legs must be retained between heats, 75 pounds in the size pouring 300 pounds and 125 pounds in that pouring 600 pounds. If the residual metal can be worked into the next charge, successive heats of different alloys can be made, but this is the more difficult as the alloys vary more widely. The furnace therefore is best fitted for long straight-away runs on the same alloy, and is poorly suited to successive runs on different alloys.

A serious condition arises due to the fact that the metal in the loop will freeze if power is off about 20 minutes, or perhaps sooner if the power should fail just after charging. Since a freeze-up ruins the lining, interruptions to the power supply, as from poor central station service, are serious.

If the furnace is to be used on single-shift operation, or shut down at night or over Sunday, it may be drained from all the metal in the loop. However, this involves delay and trouble in starting afresh. The other alternative is to leave the metal in the loop and reduce the voltage, by using the proper voltage tap on the transformer supplying power to the primary, so that just enough power is drawn to keep the contents molten. In that case it is necessary to have a man with the furnaces to dump them and save the linings in case of a power stoppage. The power thus used while the furnace is idle increases the cost of single-shift operation.

Cost is Moderate

However, even such operation does not bring the power cost per ton to an impossible figure. Collins* figures that the Ajax-Wyatt can melt, on 8-hour operation, at 300 kilowatt hours per ton, while under the same conditions

Collins, E. F., Melting Some Nonferrous Metals and Their Alloys in the Electric Furnace, Foundry, Vol. 47, 1919, pp. 284, 329.
Jour. Cleveland Eng. Soc., Vol. 11, 1919, p. 293.
Metal Ind., Vol. 17, 1919, p. 221.
Chem. Met. Eng., Vol. 21, 1919, p. 673.

FIG. 13—BATTERY OF FURNACES AT THE SAME PLANT USED TO SUPPLY THE SAME ALLOY DAILY FOR BILLETS

it takes 400 kilowatt hours per ton in a General Electric furnace. A 600-pound Ajax-Wyatt would produce about two tons in eight hours and a 1-ton General Electric not over six tons. Collins argues that the $1 per ton saving made by the Ajax-Wyatt over the General Electric, with power at 1c per kilowatt hour, is more than balanced by the lower labor cost in the larger General Electric furnace, which labor saving he assumes to be $1.25 per ton, giving a net saving of 25c per ton in favor of the General Electric. It appears to the writer that, by staggering the heats the same crew could handle three Ajax-Wyatt furnaces that could handle one 1-ton furnace of any other type. Moreover, if the power cost is 1¼c per kilowatt hour instead of 1c, the whole $1.25 per ton advantage assumed by Collins is wiped out. The superior mixing of the charge in the Ajax-Wyatt should not be forgotten in any such comparison.

It is the necessity for guarding against a freeze-up, the inability of the furnace to handle alloys high in lead or high in copper, and the difficulty in changing from one alloy to another, rather than the cost of power for keeping the residual metal hot at night, or the labor cost, that makes the Ajax-Wyatt not generally applicable to plants. This is true more especially of jobbing shops, operating only one shift.

The furnace is best adapted for use on yellow brass in rolling mill work, or in melting yellow scrap for casting into ingots, and its use is mainly confined to such work.

The prices of the standard furnaces, complete, save for step-down transformer from line voltage to 220 volts, were given, on March 29, 1920, as follows:

40 kilowatt	$5500
60 kilowatt	6500
80 kilowatt	7500

The 220-volt transformers will increase the total cost a few hundred dollars.

Larger Size Needed

The present sizes of the Ajax-Wyatt furnace are useful, but there is an undoubted need for furnaces of larger capacity. The most power that can be utilized by a single secondary loop is thought to be about 70 kilowatts, as the difficulty of getting a good power factor increases with increase in the size. Experimental work now is under way on a multiphase furnace, which probably will use about 140 kilowatts and have an output of at least 1250 pounds per hour. The Bridgeport Brass Co. also is experimenting on a larger size, single resistor, loop furnace. One taking 80 kilowatts pouring 1500 pounds, and showing around 205 kilowatt hours per ton in regular 24-hour operation on yellow brass, and having a power factor of 60 to 65, has been built. It is hoped to improve the power factor.

The Bridgeport Brass Co. reported in the middle of May that the 80 kilowatt furnace had so far turned out 925 tons on one lining without a stop and was still performing as well as when first started. On this showing, it appears that the lining cost per ton will go down to an extremely low figure in the larger Ajax furnaces.

The Ajax-Wyatt covers the field of alloys high in zinc to a rather similar extent that the stationary indirect arc type does for alloys low in zinc. The two types together nearly cover the field, but even a battery of the two types is somewhat lacking in versatility so that there still is need for such furnaces as the reflected heat or reverberatory and the rocking indirect arc types.

The application of each type to the work for which it is best fitted will be more thoroughly discussed later.

How and Why in Brass Founding

By Charles Vickers

Formulas for Pump Liners

We would like to obtain a formula suitable for pump liners weighing from 200 to 800 pounds. Also red metal mixtures containing scrap metals.

The following mixtures will make a good lining metal: Copper, 84.75 per cent; tin, 9 per cent; lead, 5 per cent; nickel, 1 per cent; phosphor copper, 0.25 per cent. Melt the copper under 2 inches of fine charcoal. When liquid the metal should not *boil* under the charcoal as this denotes the presence of gases which will produce spongy liners. Copper that boils should be ingoted, and a fresh start should be made with new copper; the gaseous copper can be used for small castings of red metal containing plenty of zinc. The copper being properly melted will be quiet, and sky blue in color when molten. Add the nickel as an alloy of 50 per cent copper; 50 per cent nickel. Then follow with the phosphor copper; allow the heat to stand a few minutes, add the tin and then the lead last of all.

Use good red scrap for making red brass. All scrap may be used, or part scrap and part new metal. Thus if 50 pounds of red machinery or valve scrap is made part of the charge, the new metal can be as follows: Copper, 42 pounds; zinc, 4 pounds; lead, 4 pounds. This will produce a good alloy.

Brass Sleeve Mixtures

Would you kindly advise us what you would recommend as the best specifications to be used in brass sleeves seven inches in length, and over.

The following alloy is excellent for brass sleeves that are used for bearings: Copper, 86.25 per cent; phosphor copper, 0.5 per cent; tin, 8 per cent; lead, 4.25 per cent.

For other uses than bearings, but where a good composition is required, the following alloy is suitable: Copper, 88.50 per cent; tin, 5.50 per cent; zinc, 3.50 per cent, and lead, 2.50 per cent. This alloy is softer than the other.

Formulas for Automobile Brass Castings

We desire to obtain brass mixtures suitable for general automobile castings, for housings and nuts, also the formula for an acid for cleaning brass castings without rattling them.

For bearings for automobiles use the following alloy: Copper, 80 per cent; tin, 10 per cent; lead, 10 per cent; phosphorus, from 0.05 to 0.25 per cent. For red brass use copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent; lead, 5 per cent. For yellow brass, use copper, 62 per cent; zinc, 36 per cent; lead, 2 per cent. For aluminum alloys use No. 12 aluminum.

A dip to remove sand from brass castings is compounded as follows: Nitric acid, 1 part; muriatic acid, 6 parts; water, 2 parts. Immerse the castings and leave in the dip 30 minutes, then remove and rinse in cold water, then in hot water; dry in sawdust in a wood lined tumbling barrel.

Correcting Defects in the Bronze Bushings

We are sending two samples of metal for inspection which may be designated as the small and the large sample. The small sample is cut from the riser of a 300-pound bushing. The riser is 1-inch diameter and the sample is a cross section cut therefrom. It is filled with holes perpendicular to the length of the riser and located around the center. We would like to learn the cause of these holes. The bushing is molded upright, and its dimensions are length, 4 feet; diameter, 7 inches; thickness of metal, 1⅛ inches. The mixture is 88-10-2 and the metal is melted in a gas-fired furnace, the casting being poured by two sprues located directly on top of the bushing, on opposite sides, so the metal drops to the bottom of the mold. There are two risers also on top of the bushing end, also opposite each other. The large sample is cut from the gate of a 60-pound half bearing, the sprue being 9 inches high and 2¼ inches in diameter. The molds are made of core sand, well baked and vented, and the metal is kept covered with charcoal while being melted.

The holes in the small sample are due to shrinkage of the riser, the metal from which has fed down into the bushing. These holes are likely to extend into the casting although nothing is said about this. The remedy is to enlarge the risers. If the castings are clean the top gating can be continued, but instead of dropping the metal directly into the mold from the crucible, it would be much better to put a cope on top of the present mold top. Bring the sprues up straight as at present and in the cope which covers the sprue tops, place a heavy ball as a feeder to the sprue. This ball must not cut through the cope. Connect the sprues to the pouring gate in the cope by a horizontal channel, and have the sprue top in the added cope set off a few inches from the termination of the straight sprue leading to the mold cavity. This breaks the fall of the metal and permits the sprue to be kept filled while pouring. The risers should be placed 1 inch away from the sides of the bushing. They should be 3 inches in diameter at least, and should connect with the side of the bushing by a square gate about 2 x 2 inches and 2 inches deep. Cut away the sand forming the angle between feeder and gate in the cope so the metal can feed without chilling. Carry the feeders through the added cope, and fill them with hot metal held especially in a small crucible.

This will produce a sound casting, but many founders would prefer to gate such a casting at the bottom, then at one or more places up the sides, and control the shrinkage by means of heavy feeders.

The metal appears to be free from gas and the melting is not at fault. An oil or gas-fired furnace carefully run with a slightly reducing flame until the metal is melted, then warmed up by a hotter flame, will produce as good metal as the crucible. The defect in the larger sample is caused by shrinkage at the gate. It is a mistake to make a triangular gate. The gate is 1¾ inches wide at the bottom, and it is 2½ inches high tapering to a point. Make it square, have it the same width, but 1½ inches deep and 1½ inches wide at the top. Also, connect the sprue to the gate in the cope by a deep fillet, eliminating the angle between sprue and gate, also fillet the sides of the gate at its connection with the casting. Do not pour the metal directly into this heavy sprue, which also forms the riser. Provide a pouring sprue placed about 4 inches away from the present sprue. Make this pouring sprue 1 inch in diameter and 6 inches high and connect to the large feeder by a gate. Carry the riser up 4 inches higher than the sprue top by means of a bushing. When the sprue is filled with metal, cover with sand, bed on a weight, then slowly fill up the riser. Do this slowly using hot metal, and the trouble will be eliminated.

Clock Pivot Mixture

We have a number of pivots to make which require to be hard as they are used in connection with clock work and revolve on sapphire jewels. We are using an alloy consisting of copper, 73.50 per cent; tin, 18.50 per cent, and zinc, 8 per cent, but after several years use the points wear off. Can you advise a mixture that will be harder, but not brittle?

If the alloy containing 18.50 per cent tin and 8 per cent zinc is too soft for the service to which it must be put, it is hopeless to experiment further with alloys of copper and tin, and the alloys of copper and zinc will also be too soft. An entirely different alloy will be required and the following mixture is suggested: Copper, 66 per cent; nickel, 24 per cent; aluminum, 10 per cent. First melt the copper and the nickel together, putting the nickel in the bottom of the crucible on a bed of fine charcoal; the copper then is filled in, more charcoal is added and the whole melted. When thoroughly liquid, add the aluminum gradually, stir thoroughly ond pour slowly and not too hot.

Extracting Silver from the Native Ore

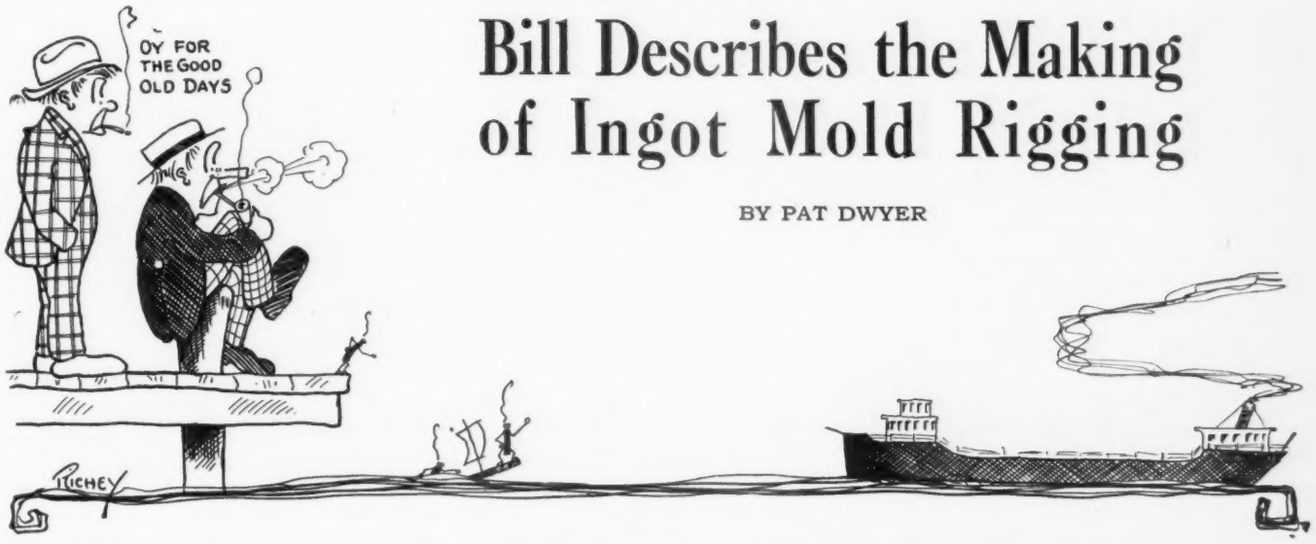
We have some silver ore running about 200 ounces to the ton that we wish to smelt, and we desire to learn if it is practical to do this in a cupola. We have two cupolas the inside measurement of which is respectively 24 and 42 inches. If we can use these cupolas we would like to know what fluxes should be used to extract the silver from the ores.

It will not be possible to recover the silver from the ore by smelting it with coke in a cupola after the manner in which iron is melted. Just what process to adopt for recovering the silver would depend upon the other metallic contents of the ore. If it is a lead ore, it could be treated by a smelting process to produce a silver-lead containing not more than 1 per cent silver. The percentage of silver is limited in order to keep down the silver loss. The silver could then be easily recovered by the Pattinson process, or the Parkes process. The silver-lead ore would require smelting with charcoal to reduce the metals. Amalgamation will have to be resorted to if no lead is present. In one process the ore is roasted with common salt, when cold it is again pulverized and then is washed with water to remove the soluble salts. The residue is put into barrels with water and scrap iron, and the barrels are rotated until the contents are thoroughly mixed when the silver is set free. Mercury is now added to form an amalgam with the silver. The amalgam is pressed and then distilled to remove the mercury, leaving the silver behind. Another method is to finely powder the ore, then mix with common salt, the amount depending upon the proportion of silver in the ore. This mixture is heated by a current of highly heated air which converts the silver to chloride. The treated ore is next washed. The insoluble silver chloride settles as a pulpy mass, which is collected, mixed with a small proportion of copper sulphate and salt and placed in steam heated iron pans. Mercury is now added in the proportion of approximately 150 pounds per ton of pulp, and the mass is ground in the heated pan for several hours at the end of which time the mercury contains all the silver.

Acid Resisting Metal

We would like to secure the formula for a good acid resisting metal.

The following alloy is frequently used for castings that are exposed to acids: Copper, 82 per cent; tin, 8 per cent; lead, 8 per cent, and zinc, 2 per cent.



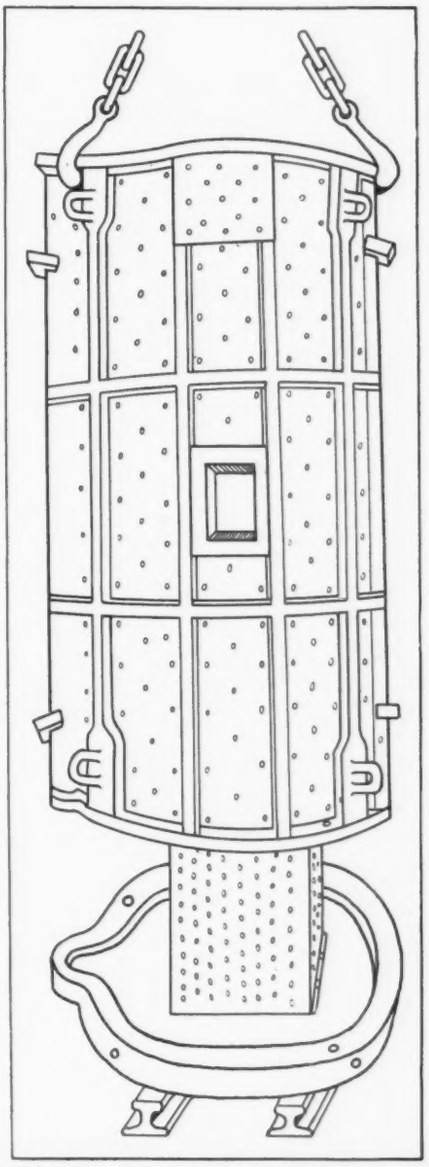
Bill Describes the Making of Ingot Mold Rigging

BY PAT DWYER

WE SAT on the end of a pier watching a huge ore steamer slowly making her way up the harbor. "If I was a young fellow again," said Bill, apropos of nothing in particular, "I would ship on a tramp steamer and see some of the queer and outlandish ports of the world. Just think of walking around the streets of cities that were proud and flourishing communities when Noah was working in the shipyard. Think of the pleasure to be derived from studying the people at first hand. I should like to check some of these things just to satisfy myself that they square with history and also with the productions of the talented gentlemen who are indigenous to Los Angeles, Hollywood and kindred localities."

"If your ambition does not extend beyond the study of human beings," I said, "you do not need to ship on a tramp steamer bound for foreign ports. You can find representatives of every race under Heaven in this city, and if you are interested in history to the extent of wondering what became of the 10 lost tribes of Israel you can set your mind at rest—they are all here, together with a fair representation from the other tribes which were not fortunate enough to get lost in the early days and only found their way over here lately. There are birds here from every port between Hong Kong and Kowloon, and from Callao to Suva and all you have to do to get on the inside track and absorb local color is to rig yourself out in a suit of old clothes, let your whiskers grow, learn to talk without removing the cigaret from your mouth and make a noise like a bunch of garlic."

"I could qualify on all the counts except the last," said he. "I have worn whiskers and old clothes and with a little practice might be able to manage the cigaret—but the garlic—boy, you said a fragrant mouthful. Garlic always reminds me of an experience I had making ingot molds for the open-hearth department of a steel works which employed a large number of foreign workmen addicted to the use of that fragrant vegetable. I have heard the chief chemist say that if some one could devise a way of incorporating a garlic breath with the molten steel as it flowed into the ladle, the resultant product would revolutionize rail making.



THE BASE, CORE ARBOR AND JACKET OF AN INGOT MOLD FLASK—THE COPE IS NOT SHOWN

"The open-hearth department with ten 50-ton furnaces had an average output of 30,000 tons of steel a month. The ingots weighed approximately three tons each, which meant that 10,000 ingots were poured each month or 333 a day. Since the measure was more or less experimental in nature, it was decided to provide sufficient equipment in the foundry to produce six ingot molds a day. With an anticipated life of even 50 heats for each mold it was expected that this number would take care of the molds broken in service. Approximately 1000 molds were stacked in the yard at the time the experiment was inaugurated and besides that the company operated its own fleet of steamers and could import foreign molds under favorable circumstances.

"Ingot molds can be and are made in many ways and the method adopted in any foundry depends upon several factors; prominent among which are molding and oven facilities, melting and crane capacity, quality of labor available and total tonnage required. Taking these factors into consideration and having investigated several prominent installations it was decided to adopt, with modifications, a method which had been described in THE FOUNDRY a short time previously.

"The principal rigging required comprised an iron pattern and core box; six base plates; 12 complete flasks, split longitudinally or perhaps I should say vertically, since the molds are all assembled and poured in a vertical position; 12 copes; eighteen 1-piece core arbors and one dummy form on which

to ram the copes. In addition to these, it also was necessary to furnish many little things to which I will refer later.

"The flask was made to conform to the shape of the ingot, with the exception that one side carried a pocket the full length to accommodate a runner. A small square opening also was provided near the center of one side of each flask. The dry sand core holding the heavy staple by which the casting afterward was handled was inserted through this opening after the mold was closed and pushed hard up against the main or upright core.

Making the Flasks

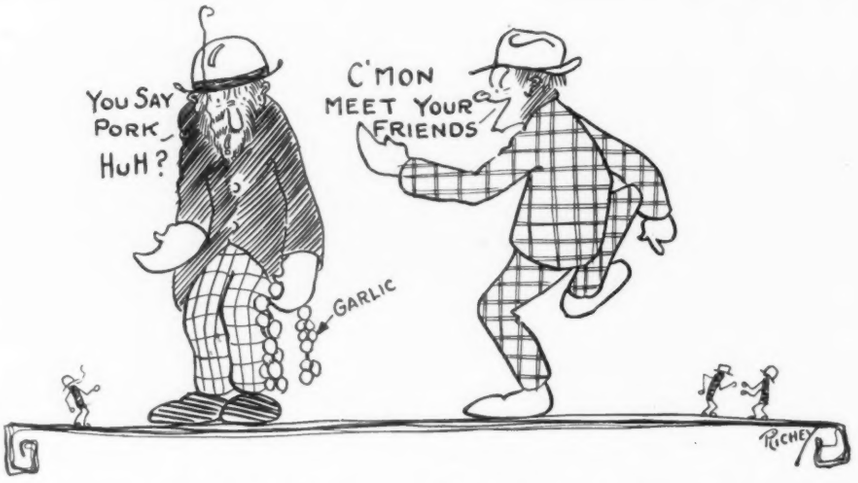
"Two skeleton patterns were made for the flasks, one for the part containing the pocket for the staple core and the other for the plain half. One pattern could have been used for both halves by leaving the pocket piece off and shifting the long side pocket from right to left for every alternate casting but it was figured that since there were so many flasks to make it would be as cheap to make two patterns as to make so many changes. The time element was another consideration. It is common foundry knowledge that two men working on individual patterns will accomplish more than if they are doubled up on one. The patterns were bedded in the floor and the inside lifted by substantial cast iron arbors attached to the copes by long eye bolts. Owing to other work, only two men were available for the ingot-mold job, but by taking a pattern each they turned out two sides for a flask each alternate day.

"The copes were solid one-piece castings, plain on top but having a flange on the face side corresponding in shape to the flange of the flask. The core arbors were also one-piece castings having a large opening at one end and a small opening at the other, and with an average metal thickness of 1 inch. The pattern for the arbor was molded diagonally, that is to say it was laid in the floor horizontally and the parting made along two diagonal corners. This method was adopted to facilitate placing the great number of small cores which were set in to provide a vent for the core when the arbor would be in use. If the pattern had been molded on its flat it would have been necessary to leave sufficient clearance between the cores on both sides for lowering the main core into the mold; and as a result it would have been necessary to punch quite a thickness of metal out of all the holes when cleaning the casting. By molding it diagonally it was possible to leave the little cores the full length. If the main core *did* happen to bear on them a little hard it did no harm but was simply an added assurance that the holes would be clear and open when the casting was cleaned. These small cores were tapered and attached to the mold by inserting a wire nail in a hole which had been provided for that purpose in each of them. The large end of the cores rested on the face of the mold.

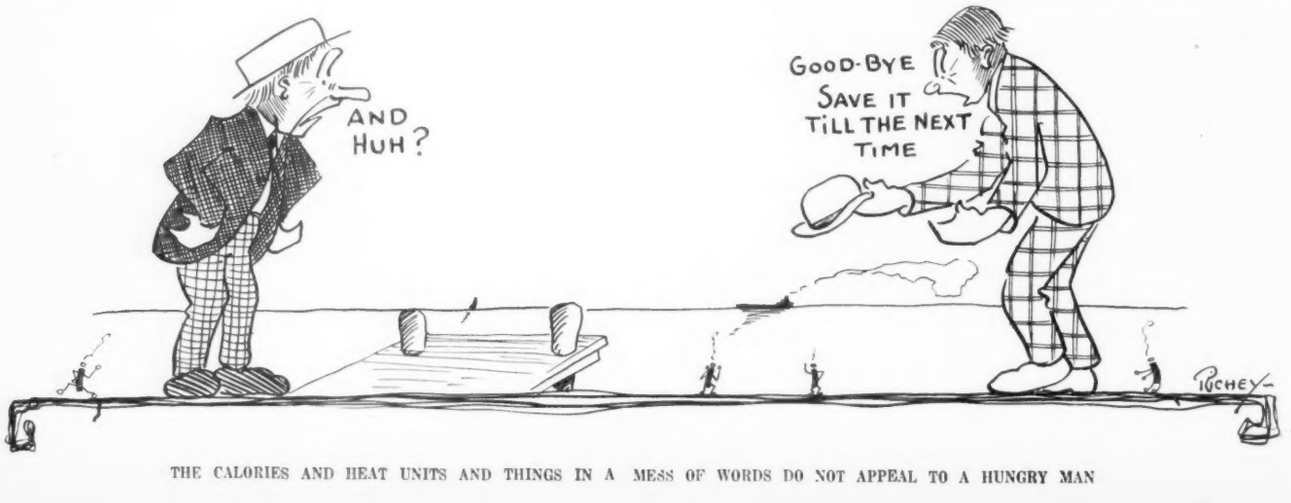
"The bottom plates were substantial one-piece castings provided with four cored 1-inch holes, one at each corner for convenience in handling. The upper face contained two recesses, the first which corresponded in shape to the inside of the flask was about an inch deep and was designed to hold a thickness of sand to form the bottom face of the ingot mold; while the second recess extended almost through the plate and was provided with fitting strips which afterward were machined to fit the bottom or core print of the arbor. These core prints, both on the arbor and on the bottom plate, all were accurately machined to the same dimensions so that the arbors were interchangeable and when in use it was never necessary to roll them over to look for identifying marks. Any one of the arbors would fit any one of the bottoms.

"The lower flanges of the flasks and also the face of the bottom plates which came in contact with the flanges also were machined to a true fit. The pin holes for locating the flasks in their proper relative position when closing the molds were drilled through a jig and therefore the flasks also were interchangeable.

"To provide a pattern it first was necessary to make a master pattern and core box allowing for the shrinkage. The master pattern was molded in dry



AFTER 20 CENTURIES OF WANDERING THEIR BREATH IS AS STRONG AS EVER



THE CALORIES AND HEAT UNITS AND THINGS IN A MESS OF WORDS DO NOT APPEAL TO A HUNGRY MAN

sand, not because it could not have been molded in green sand, as it was only a shell ¾-inch thick, but for the protection the dry sand method afforded against any possible swells on the face of the casting.

Hinged Corebox Used

"The core box, consisting of two halves, was made of cast iron. It was joined together at the back by three hinges and held together in front by a catch which locked by a cam arrangement. One pattern was used for molding both halves. It was necessary only to change the position of the hinges after the first half had been made. The catch was made separately and bolted on after the corebox had been machined and assembled. When in use, the corebox rested on a planed iron plate with a depression in the center corresponding to the depression in the center of the bottom plate which has already been mentioned.

"The pattern also rested on a planed iron plate provided with two pins which served to locate the flasks when they were lowered on for ramming. The pattern was made ¾-inch over the required length to allow for a brass stripping plate. After each mold was rammed this plate was clamped to the lower flange until the mold had been lifted about a foot. The clamps then were knocked off and the plate allowed to drop back into position for the next mold. Considerable trouble was experienced at first in making the molds. The pattern was not anchored because it was considered that the combined weight of the pattern and plate would be sufficient to overcome the attraction of cohesion between the pattern and the sand forming the mold. Experience proved that such was not the case. In attempting to lift the jacket the pattern would come with it and it was necessary to strike the latter several times with a heavy wooden mallet before it would drop to its place.

"The trouble was cured by attaching two sections of 80-pound rail to the bottom of the plate supporting the pattern and then anchoring the ends of the rails in the concrete walls of the pit in which the molds were made. The pattern was bolted to the plate through four light lugs and to offset any possibility of these lugs breaking it was decided to employ additional safeguards. Accordingly a 1½-inch bolt was made long enough to extend from the top and through the center of the pattern to below the rails. A washer and nut were placed on each end and it then was a safe bet that the crane chains would break before the pattern would shift.

"After some delay in the machine shop the flasks, plates and arbors were delivered to the foundry and a gang of helpers chaperoned by a duly qualified molder were turned loose and told to eat it up. There are no difficult or complex factors to contend with in ramming ingot molds and a gang of six men were able to turn out six molds a day in a short time. The molds were good looking both inside and out and when placed in use in the open hearth they stripped clean.

"Lots of foundry difficulties start after all troubles seem to be over. This job was swinging along smoothly in the foundry when complaints began to arrive from the open hearth that the new molds were not giving service. Their maximum life seemed to be about 50 heats while some of them cracked and had to be discarded after only being in use a few times. The foreign molds had an average life of over 100 heats. Some of them ran up to 150 heats. The trouble was traced to the metal used, according to the opinion of those concerned.

"One of the company's blast furnaces ran on foundry iron but owing to the nature of the ore and coke in that particular part of the world the resultant pig iron carried exceedingly high percentages of sulphur and phosphorus. A sulphur content of from 0.10 to 0.20 per cent and phosphorus from 1 to 1.25 rendered it altogether out of the question for ingot molds. Instead of pig iron, old broken ingot molds were charged in the cupola together with sufficient ferrosilicon and ferromanganese to bring the iron up to the analysis of one of the foreign molds which had been analyzed for that purpose. Analyses and tests were taken every day and the iron kept as near as possible to a fixed standard; but the molds continued to break.

"The job finally was abandoned after a couple of years and then under a change of management was resurrected again. One of the men who had taken an active part in designing the rigging for the early experiments was still in the employment of the company but in a more important position. He had done considerable thinking over the ingot problem and when he had the opportunity the second time, he decided to try out a theory which he had developed. He had the design of the mold changed making the corners thicker and the sides thinner and he got a set of molds that had the foreign molds backed right off the map when it came to showing records of heats poured."

"All right," I said, "if you now will kindly make a motion to adjourn I will second the same with great pleasure. I have a record down around our way of having never missed an evening meal and I don't wish to lose it, and besides it might arouse suspicions."

Metallurgical Theories Conflict

(*Concluded from page* 468)

varying from 0.05 to 0.5 per cent on the mechanical properties of malleable cast iron. The addition of phosphorus does not improve the mechanical properties of malleable while above 0.20 per cent the properties are impaired.

TOUCEDA, E. Permissible Phosphorus Limits in Malleable Iron Castings. American Foundrymen's association transactions, 24, p. 209, 1916. Finds phosphorus up to 0.325 per cent content has no effect on the grain size of malleable. The evil effects of phosphorus are slow to make themselves felt if the combined carbon is low.

Some changes have been made on the joint committee: The United States shipping board has been succeeded by the Society of Naval Architects and Marine Engineers, represented by F. W. Wood, vice president, International Shipbuilding Corp., Philadelphia.

The place on the joint committee left vacant by the discontinuance of the United States railroad administration has been taken by the American Railroad association, mechanical section. H. B. MacFarland, Atchison, Topeka & Santa Fe Railroad Co., Chicago, and F. M. Waring, Pennsylvania railroad, Altoona, Pa., have been appointed to represent the railroad association.

This report of the joint committee is the second one issued. The first report was noted in THE FOUNDRY of April 15.

Munition Plant Converted to Peaceful Use

An interesting aftermath of the war noted by the American Chamber of Commerce in London is the proposal by the Irish Farmers union comprising 50,000 members, and a number of other Irish co-operative societies to produce agricultural implements of all kinds in Ireland. It is understood that an option has been secured on Kynoch's munition works at Arklow, County Wicklow, with this object in view. Negotiations are practically concluded for raising $1,250,000 to finance the project.

The Kynoch munition plant covers 3000 acres on which there are 400 buildings, including workmen's dwellings, social clubs, canteens, etc.

It is the intention of those interested in the undertaking to start work on agricultural castings, develop into agricultural machinery and ultimately turn out everything a farmer requires. Electric and steam power are said to be available to the extent of 6000 horse power and the different units of the works are linked together by 37 miles of railroad. An elevated railroad connects the plant with private wharves where several large electric cranes are already in existence.

Correcting Flaws in Metals and Mixes

Problems of the Gray-iron, Malleable and Steel Foundry Discussed

By H. E. Diller

Car Wheel Scrap Softened by Ferrosilicon

Question—What per cent of silvery pig iron should I use with car-wheel scrap to obtain an iron easy to machine?

Answer—The amount of silvery pig iron to use will of course depend upon the percentage of silicon in the silvery iron. This has a wide range of composition. You should have a resulting iron with from 1.75 to 2.20 per cent silicon, depending upon the thickness of the section of your castings. When using an 8 per cent ferrosilicon you would need to have 25 per cent of the mixture ferrosilicon, if you use nothing with it but car-wheel scrap. This could be figured in the following manner, which will illustrate the method of calculating to be used for ferrosilicon with any amount of silicon and to obtain any amount of silicon in the cast iron.

	Weight		Per cent silicon		
Ferrosilicon	250	×	8.0	—	2000
Car wheel	750	×	0.6	—	450
	1000				2450
Per cent silicon.....					2.450
Loss in melting.....					.25
Resulting silicon—per cent.....					2.20

In this connection we would call to your attention that it is difficult to mix in the cupola two irons which vary so widely in their silicon contents. For this reason care should be taken to allow at least one charge of metal to be melted in the bottom of the cupola before tapping each time.

Mixture for Hard Iron

Question.—We want to make hard, white-iron pipe castings for use in conveying ashes and cinders from the boiler room to the ash pit. Will you kindly tell us what kind of iron to use? Would steel in the mixture be of any benefit?

Answer.—Castings such as you mention should run low enough in silicon and high enough in sulphur to cause all of the carbon to stay in the combined form. Free carbon will produce gray or mottled iron and if you find this condition you will know that you must use a lower silicon iron. If you use chills in the molds it will not be necessary to run the silicon so low.

Without using chills we would recommend that you purchase an off-iron with 1 to 1.50 per cent silicon and high sulphur, say around 0.07 or 0.08 per cent. It would not be advisable to use any scrap except what you make yourself unless you can conveniently secure some low-silicon scrap of fairly uniform composition. We would not recommend the use of steel in your mixture as the steel increases the shrinkage and would give more trouble in this hard iron which is already high in shrinkage, without benefiting the iron for your purpose. It must also be borne in mind that white iron castings are easily broken, and for that reason discretion must be used in preparing the mixture so that it will have the necessary strength as well as hardness.

Cylinders for Refrigerating Machines

Question—Occasionally we have calls for cylinder castings to be used on refrigerating machines for pumping ammonia. We would be pleased to receive some information regarding the kind of iron best suited for this purpose.

Answer—Cylinder castings for use in refrigerating machines require a close grained iron. This can be secured by a mixture of 30 to 40 per cent gray-iron scrap; 10 to 15 per cent steel scrap and the remainder pig iron. The stock should be of such a composition that you secure a low phosphorus metal, ranging from 0.20 to 0.30 per cent phosphorus. The silicon content should be between 1.50 and 2.20 per cent depending upon the thickness of the section of the cylinder, the lower silicon being used with cylinders of the thicker sections. The proper amount of silicon may be gaged by the amount of combined carbon found in the metal. This should not be lower than 0.50 or higher than 1 per cent. Sulphur should be kept below 0.10 per cent if possible, and manganese may range from 0.50 to 0.80 per cent.

While the composition of the iron is important, a good iron cannot be secured unless proper melting methods are employed. Care should be taken to see that the iron is hot. The cupola should be well fluxed, and enough coke should be added to the bed and between the charges to prevent oxidization.

Castings Made from Crucible Steel

Question—We wish to use our crucible furnace equipment occasionally to make small steel castings, using boiler punchings as melting stock. Will you please advise us what alloys we should add to obtain a soft steel?

Answer—When using boiler punching stock for making soft steel for castings, in the crucible, it is necessary to add sufficient silicon to bring the silicon in the metal up to between 0.20 and 0.30 per cent. This would probably best be added in the form of 50 per cent ferrosilicon. The manganese in the finished steel should run between 0.45 and 0.55 per cent. In order to secure this percentage of manganese it may be necessary to add a small amount of that metal in the form of 80 per cent ferromanganese. The carbon in soft steel castings should range between 0.20 and 0.30 per cent. The punchings as melted down would probably contain this amount of carbon. Should it be necessary to increase the carbon content, some coke dust, retort carbon or petroleum coke should be placed in the bottom of the crucible before the charge is put into the crucible. This is desirable because a low carbon steel would be difficult to melt and the increase of carbon would raise the melting point.

A Substitute For Malleable Iron

Question.—What metal will come the nearest to giving the same service as malleable iron?

Answer.—No metal will give identically the same service as malleable iron for castings. If strength is required, soft steel, with carbon between 0.20 and 0.30 per cent, would be a good metal to substitute. Some foundries substitute a brass which is somewhat lower than malleable iron in tensile strength, when strength is not required and the castings are desired in a hurry. A brass composed of copper, 84.0; tin, 12.0; zinc, 3.5, and lead, 0.5 per cent would have a tensile strength of 28,000 pounds per square inch. In melting this brass 2 per cent of phosphor-tin is sometimes substituted for the pure tin.

Twister Wrecks Foundry

What a tornado can do to a foundry is shown in the accompanying illustrations, from photographs taken for the Charles C. Kawin Co., foundry engineers, Chicago, after the storm that hit St. Johns, Mich., Sunday, March 28. They show the wreck of the Industrial Foundry Co.'s plant, owned principally by John Spousta.

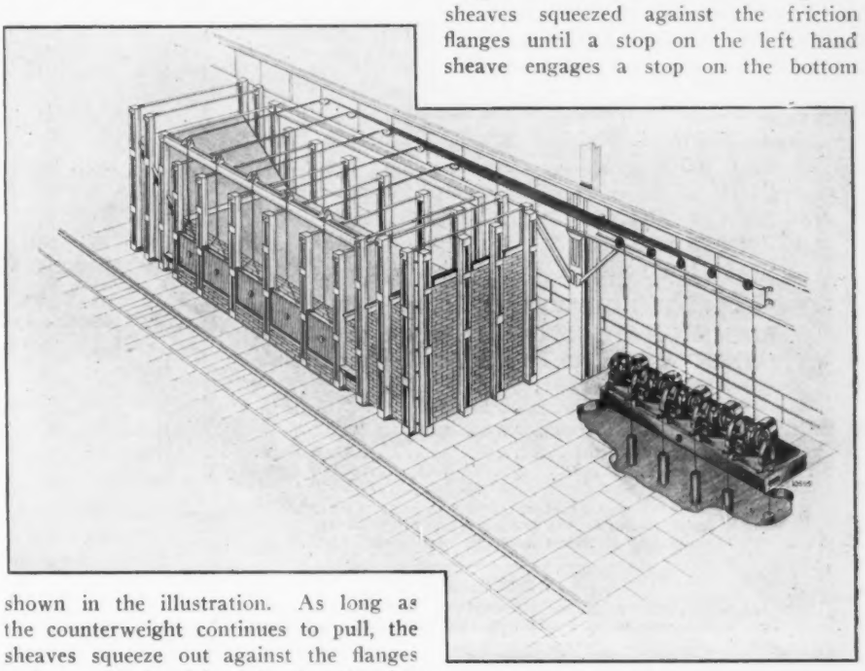
When the storm had passed, leaving the older portion of the foundry flat and the newer portion unroofed the Kawin service was appealed to by wire and a representative was on the job Monday morning. Plans for rebuilding were back in St. Johns Wednesday in readiness to begin work.

However, Mr. Spousta had been figuring on removing to Howell or Hillsdale, Mich., and decided not to rebuild until he comes to a conclusion as to his location. Instead, the foundry has been roofed and operations resumed on a lessened scale. An interesting development was the earnestness with which all the employes turned to the task of clearing wreckage and replacing the roof, as the only means for resuming their labors. Only one man of the entire force demurred at doing this work and the remainder used every effort to restore order.

An Automatic Control for Furnace Door Hoist

A positive automatic device which prevents heavy furnace doors such as those used on open hearth and heating furnaces from being lifted or lowered too far, has been developed by the Link-Belt Co., Chicago. The device forms an integral part of a hoist which is made in several sizes adapted to varying loads. On each hoist is mounted a pair of chain sheaves attached to a worm wheel shaft between two flanges which are pinned to the shaft and supplied with fiber friction surfaces on the sides toward the sheaves. The worm wheel is driven by a worm mounted on the shaft of a reversible motor, the worm and wheel being inclosed in a suitable housing.

To raise the furnace door the motor is started in the direction which will pull down on the left hand chain as shown in the illustration. As long as the counterweight continues to pull, the sheaves squeeze out against the flanges and are thereby driven in the direction which will wind up the left hand chain and thus lift the door.



DIAGRAMMATIC VIEW OF HOIST IN POSITION

The right hand sheave has a fixed stop on its periphery so located that it will come in contact with a stop on the bottom casting when the furnace door has reached its proper height. With the motion of the right hand sheave arrested by this stop, the shaft cannot rotate the left hand sheave because the forced contact between the sheaves and the friction flanges is relieved. Over winding is impossible and if through carelessness the current is not shut off promptly the aft with its flanges simply will continue to revolve but without the power to grip and rotate the sheaves.

For lowering the doors the direction of the motor is reversed and practically the same process repeated except that in this case the motor lifts the counterweight, while the pull from the weight of the door serves to keep the sheaves squeezed against the friction flanges until a stop on the left hand sheave engages a stop on the bottom casting and prevents over winding of the counter weight chain in the manner already described. The motor is started, stopped or reversed by the ordinary push button mechanism.

The Electric Furnace Construction Co., Philadelphia, has appointed H. M. Smith as its agent in Cleveland. Other agencies established by this company include San Francisco with A. S. Lindstrom in charge; Birmingham with McCrum & Gillem, agents; and St. Louis where the General Welding & Supply Co. has been chosen.

AT THE LEFT IS SHOWN THE NEWER PORTION OF THE INDUSTRIAL FOUNDRY CO.'S PLANT AFTER AN ENCOUNTER WITH A RECENT TORNADO —THE EXTERIOR VIEW AT THE RIGHT INDICATES THAT THE CUPOLA IS INTACT

THE FOUNDRY

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Theories Accepted too Readily

THE world is quite inclined to take things too much on hearsay or to believe the first plausible theory which presents itself to account for established phenomena. This is true of the foundry industry as well as of the world at large. Possibly one consideration which inclines to this mode of reaching conclusions is that great expense often is involved in testing or disproving beyond question a theory advanced. For years steel manufacturers and users have accepted without reservation the statement that sulphur and phosphorus are injurious to steel, and have made the limits for these elements as low as possible in their various steel specifications. Basic open-hearth steel is held to the lowest possible limits, while acid open-hearth steel is allowed a slightly higher percentage of both phosphorus and sulphur. Bessemer steel may have approximately twice as much sulphur and phosphorus as basic open-hearth steel. The variations in the allowable limits in steel made by the different processes perhaps may be accounted for by the nature of the process. In the basic open-hearth, the phosphorus of the original charge may be greatly reduced and the sulphur content may also be somewhat lowered, but in the acid process the percentages of both of these elements is slightly increased. Again in the bessemer process the sulphur is considerably augmented when the charge is melted in the cupola, and the percentage of phosphorus is raised. Now after all these years during which the pronouncement of some metallurgists and steel users was accepted, the theory as to the effect of sulphur and phosphorus on steel is seriously questioned and investigations have been started to determine definitely the limits above which these elements are injurious to steel. Some light also is sought as to whether there are not some qualifications which make sulphur and phosphorus either injurious or harmless.

In the iron foundry, phosphorus is not considered injurious to all grades of metal and in some cases it is held to be decidedly beneficial. Even in the most extreme cases, it never is kept as low as the maximum limits insisted upon for phosphorus in basic open-hearth steel. Sulphur is accorded a different reception in most iron foundries where it is regarded as detrimental in any amount above the quantity determined by the lowest amount which commercially can be secured. However, a few foundries do not so regard it. Some car-wheel foundries in particular pour iron with as much as 0.220 per cent sulphur and maintain that this amount is advantageous to the metal. Again, in white-heart malleable the sulphur at times amounts to over 0.50 per cent without any apparent injury to the iron.

Possibly the conclusions regarding the deleterious effects of sulphur on cast iron have been too hastily accepted. The largest part of the sulphur content in iron comes from the coke used and it may be that there is some other quality in high-sulphur coke which makes the iron sluggish and causes gas holes in the castings. The fact that the increase in sulphur is easily determined may have been the basis for the charge that it is detrimental to the iron. This is partly substantiated by the statement of one metallurgist who has noticed that iron is differently affected by sulphur which is taken up in the cupola, than by sulphur which forms one of the component parts of the iron as it leaves the blast furnace.

Trade Outlook in the Foundry Industry

BRIGHTER prospects are evident in the industry in general, due to the slowly clearing railway situation, which through stagnation at terminals has threatened operations in every foundry of the country. Coke, pig iron, coal, sand and scrap consequently are moving more freely than they did two weeks ago, and production is increasing. The car shortage which has been a factor of great concern for some time, continues to be little improved.

Optimism Prevalent

General business conditions as they react directly upon the castings demand, show few evidences that would warrant extreme pessimism. Credit is tight. Price reduction agitation has led to a falling off in the public's demand for wearing apparel, and building trades have been strongly affected due to the general cessation of construction operations. However, the entire iron and steel business is established upon a much more stable foundation. Exorbitant charges, common in many merchandising lines, have been almost entirely absent in the various branches of the metal industry and therefore there is less pressure tending to reduce prices. Further, the greater portion of all iron and steel products has gone to make up standard and essential articles of commerce, necessities of an established character. That the automobile business has absorbed a great part of the output of central western steel plants and foundries, and that passenger cars commonly are deemed nonessentials, does not alter the situation. Passenger car manufacturers deny the luxury classification ascribed to their product, stating that a large percentage of the automobiles purchased as passenger cars are for business purposes. Regardless of the merits of this contention, the fact remains that the demand for this class of cars remains stable, and although some cancellations are reported, the advance orders were in such volume that the entire scheduled production probably will be needed to meet the requirements. It is stated that the shortage of raw materials and credit difficulties may force a reduction of about 35 per cent in the 1920 estimated output of passenger cars, but this will little more than allow capacity for needed castings.

Prices of Raw Materials for Foundry Use

CORRECTED TO JUNE 7

Iron		Scrap	
No. 2 Foundry, Valley	$44.00	Heavy melting steel, Valley	$24.75 to 25.00
No. 2 Southern, Birmingham	42.00 to 44.00	Heavy melting steel, Pittsburgh	25.50 to 26.00
No. 2 Foundry, Chicago	43.00 to 45.00	Heavy melting steel, Chicago	22.00 to 22.50
No. 2 Foundry, Philadelphia	45.60 to 48.10	Stove plate, Chicago	32.00 to 32.50
Basic, Valley	43.50	No. 1 Cast, Chicago	42.50 to 43.00
Malleable, Chicago	43.50	No. 1 cast, Philadelphia	37.00 to 39.00
Malleable, Buffalo	46.25	No. 1 cast, Birmingham	30.00 to 33.00
Coke		Car wheels, iron, Pittsburgh	41.00 to 42.00
Connellsville foundry coke	13.00 to 15.00	Car wheels, iron, Chicago	36.50 to 37.00
Wise county foundry coke	12.00 to 12.50	Railroad malleable, Chicago	28.75 to 29.25
		Agricultural malleable, Chicago	28.50 to 29.00

Requirements Above Normal

Gray iron shops, except where hampered by continued transportation difficulties, are busy and have orders on their books which extend through the next six months. A few exceptions are noted where manufacturing establishments have asked deferred deliveries pending the receipt of other needed materials. Automobile castings makers, in general, have had only a few cancellations and the demand continues briskly. Local difficulties have led a number of eastern automobile makers to inquire among western foundries for castings to meet their needs. In the south, a steady increase in sugar machinery requirements is noted, and in Birmingham, Cuban interests maintain staffs of buyers and inspectors to expedite shipments of sugar mill equipment. Malleable plants are working steadily, sustained by a steady current of orders. Implement manufacturers, the automotive industry and the electrical trades are furnishing the bulk of demand. Railway car manufacturers are not yet calling for any great tonnage of castings, from general jobbing shops, but those foundries directly connected with the car building industry are again in operation, and car wheel foundries which during the past few years have operated mainly upon replacement work, again are approaching full operation.

Iron Output Improves

The lessening grip of the railway strike is reflected in the improvement of pig iron production during the month of May. According to reports secured by *The Iron Trade Review*, the total tonnage for May was 2,991,825 as compared with 2,752,670 tons as reported for April. This represents a net gain of 239,155 tons. The average daily production was increased by 4756 tons, to 96,510 tons per day. A greater gain was registered by steel works than by merchant furnaces. The total of merchant iron produced is shown to be 808,751 tons in May as compared to 761,331 tons for April. This is an average of 26,088 tons per day for May and 25,337 tons per day for April, a gain of 751 tons daily. Demand for last half iron is almost neglible at present. Producers state that a great amount of first half iron is going forward into the last half for delivery. Coke for immediate delivery is in strong demand and premium prices have been paid by foundrymen unable to secure fuel which they have contracted at lower prices. It is felt that the present price level for coke is a peak and that a recession is due, particularly since transportation improves daily in the producing regions. Coke deliveries have improved greatly, but have as yet failed to catch up with the consumption. St. Louis foundries report an unsatisfactory prospect, as fuel is not being delivered in quantity, future orders are taken subject to a sort of rationing system which permits the producer to cancel rather than defer shipping in event of inability to delivery at the stated time. This confusing feature adds to an already complicated situation.

Nonferrous foundries are operating normally, with a fair volume of new business. Prices for nonferrous metals, based on New York follow: Copper, 18.12½c to 18.25c; lead, 8.87½c to 9.00c; tin, 47.75c to 48.00c; antimony, 8.62½c to 8.87½c; aluminum, No. 12 alloy, producers' price, 32c and open market, 31c. Zinc is quoted at 7.62½c to 7.70c, St. Louis.

Comings and Goings of Foundrymen

CARL G. BARTH, a pioneer in machinery building industry and to whom many other industries owe modern principles of production and management, has been elected an honorary member of the Taylor society. Only two other men have been thus honored by the society, which is the national organization for the promotion of science in management, these being Frederick W. Taylor himself and Henri Le Chatelier, the prominent engineer who developed scientific management in France. Mr. Barth, after engineering studies in his native land, Norway, came to this country in 1881 and was employed as a draftsman by William Sellers & Co., where he remained for 14 years, with the exception of one year. From 1895 to 1899 he was engaged in designing and engineering work in St. Louis; in technical mathematics and manual training and in preparing engineering text books. Then he became associated with Mr. Taylor at Bethlehem with whom he worked on the historic foundations of scientific management. Under Mr. Taylor's guidance he conducted experimental work in the plants of the Link-Belt Co. and the Tabor Mfg. Co., Philadelphia.

P. M. Sullivan has been made foundry foreman for the Railway & Mining Supply Co., Kincaid, Ill.

W. L. Chatfield has been named superintendent of the new plant of the Central Foundry & Supply Co., Nitro, W. Va.

Rev. M. J. Prestidge has been elected president of the Dundee Foundry Co., a newly organized company which is operating an aluminum and brass foundry at Dundee, Mich.

W. T. Myer has been appointed by D. Gleisen, manager, to be directing transmission engineer of the industrial bearings division for the Hyatt Roller Bearings Co., New York.

William H. Kochenderfer, formerly with the Southwark Foundry Co., Philadelphia, has been made general manager of the Chambersburg Foundry & Machine Co., Chambersburg, Pa.

Charles A. Herrmann, formerly chief chemist for the Edward B. Lemon laboratories, Milwaukee, has been appointed to the bureau of chemistry, United States government laboratory, New York.

Carl G. Broehm, formerly foundry superintendent of the Michigan Lubricator Co., Detroit, manufacturer of brass goods, now is secretary of the LeRoy Broehm Foundry Co., 932 Jefferson avenue east, that city.

O. E. Paris has resigned his position as foundry foreman for the Mann Corp., Kankakee, Ill., to become foundry superintendent for the River View Foundry Co., a new plant which has been established at Aurora, Ill.

Carl Aichberger has resigned as secretary and sales manager of the Sandusky Foundry & Machine Co., Sandusky, O., and is now connected with the Fitzpatrick Products Corp., 99 John street, New York, in an executive capacity.

Charles D. Meikenhaus, who for the past three years has been assistant superintendent of the Whiteley Malleable Castings Co., Muncie, Ind., recently has been made superintendent of the Denver Rock Drill Mfg. Co.'s foundry at Denver, Colo.

Livingston Middleditch Jr. has joined the heroult electric furnace department of the United States Steel Corp. as a salesman. Mr. Middleditch originally served at the Gary and South works of the United States Steel Corp., and recently has been connected with the Consolidated Steel Corp.

M. Samuels & Co., Ltd., 25-27 Bishops Gate, London, England, have been appointed general representatives in England of the Foundry Equipment Export Corp. Alba B. Johnson Jr., manager of this corporation, now is in England and he is making his headquarters with the Samuels company.

Glenn L. Orr recently has been elected secretary and treasurer, and has been made general manager for the Lansing Foundry Co., Lansing, Mich. Mr. Orr is well known in Detroit automobile circles through his previous connections with the Detroit Engine Works, Hupp Motor Corp., Packard Motor Car Co., and Briscoe Motor Corp., Jackson, Mich.

J. D. Drugan recently has accepted a position as metal pattern maker for the Buick Motor Co., Flint, Mich. Mr. Drugan's experience covers over 13 years, during which time he has worked on the production of metal patterns for the United Shoe Machinery Corp., Beverly, Mass., Framingham Foundries, and the Wright Martin Co., New Brunswick, N. J.

Eugene Schoen, general manager of the International Oxygen Co., Newark, N. J., has sailed for Europe to make an inspection of the company's branches in London and Paris and to extend the scope of operations in France, England, Belgium, Germany, Switzerland, Sweden and Denmark, where an increasing demand for oxygen and hydrogen generating apparatus is reported.

Henry Berlinger, who has had a wide experience in the nonferrous metals trade, has become affiliated with the Sandusky Foundry & Machine Co., Sandusky, O. Mr. Berlinger formerly was eastern sales representative for the Michigan Smelting & Refining Co., Detroit. He will develop business in new lines for that company's fluid compressed bronze castings and in the purchase of nonferrous metals.

Victor T. Noonan, formerly affiliated with the Bethlehem Shipbuilding Corp., has become affiliated with the Smith Insurance Service, Inc., 185 Devonshire street, Boston, in the capacity of consulting accident prevention engineer. Mr. Noonan formerly was safety director of the industrial commission of Ohio and as chairman of the committee on accident prevention of the American Foundrymen's association was instrumental in compiling the safety code adopted by that organization.

George E. Long, who recently was re-elected to the board of directors of the Joseph Dixon Crucible Co., Jersey City, N. J., at the annual election and who has been actively connected with that company for 43 years, has announced his decision to retire from the senior vice presidency. Mr. Long entered the service of the company as stenographer and was advanced through the office of the secretary, treasurer and vice president to the position which he held at the time of his retirement.

Engineers Study Casting Production Problems

The most important session of the spring meeting of the American Society of Mechanical Engineers was given over to a symposium on castings, comprising six papers covering malleable, die, aluminum, steel, gray iron and brass castings. This meeting, held Wednesday morning, May 27, was presided over by Frank O. Wells, president, Greenfield Tap & Die Corp., Greenfield, Mass.

Richard Moldenke, Watchung, N. J., opened the discussion with a paper on gray iron castings, in which he emphasized that castings of this material may be produced to meet a wide variety of requirements. He pointed to the use

of high proportions of scrap in the cupola during the war and declared that this practice will be paid for within the next 20 years when the high-sulphur and oxidized iron will return from the scrap piles to be used again. This problem will be met, he said, either by using an increased amount of pig iron or by developing a practical desulphurizing process. Suitable desulphurization can be had by melting in the cupola and transferring the charge to a basic-lined electric furnace.

The shrinkage of steel castings was discussed in connection with a paper by John H. Hall, Taylor & Wharton Steel Co., High Bridge, N. J. Arthur M. Greene, Rensselear Polytechnic institute, Troy, N. Y., read a paper prepared by Prof. Enrique Touceda on malleable castings. Capt. J. L. Hughes, ordnance department, United States army, explained experiments made by the government with malleable bombs, stating that difficulty was found in eliminating porosity. Charles Pack, Doehler Die Casting Co., Brooklyn, N. Y., discussed recent developments in die casting and in the absence of Zay Jeffries, Aluminum Castings Co., Cleveland, presented the latter's paper on aluminum castings. The subject of permanent molds came up for considerable discussion, the opinion seeming to prevail that investigators should search for *long-life* molds instead of *permanent* molds.

Converted to Iron Foundry

The Standard Process Steel Corp., Phillipsburg, N. J., has been reorganized, new equipment has been added and practically the entire plant will be given over to the manufacture of large and small gray iron castings on molding machines. Ralph Sleicher, Troy, N. Y., has been appointed general manager of the foundry. Mr. Sleicher is peculiarly well fitted for this position as he was for a number of years with the West Side Foundry in Troy and largely contributed to its success. The sale of the entire output of the plant has been placed in the hands of J. W. Sanders Co. of 30 Church street, New York city, as agents.

The Sandusky Foundry & Machine Co., Sandusky, O., recently was reorganized when W. H. Millspaugh, repurchased holdings he sold three years ago to Irving Brown and other Cleveland men. Mr. Millspaugh was elected president; Judge W. C. Boyle, Cleveland, vice president; Louis A. Stroh, Sandusky, treasurer, and F. S. Whitcomb, Cleveland, secretary.

The Adirondack Steel Foundries, Inc., Watervliet, N. Y., have completed a new steel foundry and will put it in operation about June 15. It is equipped with both open hearth and electric steel furnaces.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

Erection of additions to the plant of the Interstate Foundry Co., Cleveland, is contemplated.

A plant will be established at Ravenna, O., by the National Furnace & Stove Co.

Erection of a foundry and forge shop has been started by the Wright Mfg. Co., Lisbon, O.

Fire recently damaged the foundry of the Gross Mfg. Co., West Hazleton, Pa. It will be rebuilt.

The C. H. Turner Foundry Co., Statesville, N. C., plans the erection of a foundry, 40 x 50 feet.

An addition, 70 x 180 feet, is being planned by the Wilmington Casting Co., Wilmington, O.

Erection of a foundry is contemplated by the Columbian Foundry Co., McKeesport, Pa.

The Kennedy Corp., Baltimore, plans the erection of a foundry.

Bauer Bros., Springfield, O., plans the erection of a foundry building, 200 x 250 feet.

The plant of the Riverside Steel Castings Co., Kearney, N. J., recently was damaged by fire.

Fire recently damaged the plant of the Record Foundry & Machine Co., Moncton, N. B.

The F. Rassmann Mfg. Co., Beaver Dam, Wis., is increasing its foundry capacity.

The Fulton Iron Works, St. Louis, contemplates the erection of an addition to its foundry, 112 x 120 feet.

Fire recently damaged the plant of the Gravois Foundry Co., 5007 South Thirty-eighth street, St. Louis.

Plans are being drawn for the erection of a pattern shop for the Lebanon Steel Co., Lebanon, Pa. The building will be 55 x 110 feet.

Shranger & Johnson, Atlantic, Iowa, have started work on the erection of a foundry building, 110 x 200 feet.

Automobile castings will be produced in an addition to the plant of the Almont Mfg. Co., Almont, Mich., which is now under construction. The addition will be 70 x 80 feet.

W. C. Arnold, M. Elliott and Frank A. Cabeen Jr. were named as the incorporators of the Chambersburg Foundry Co., which was recently chartered with a capital stock of $50,000, at Philadelphia.

The Ruka Foundry & Machine Co., Boscobel, Wis., has leased its plant for six months to the Hunt Mfg. Co.

The capital stock of the Grand Rapids Brass Co., Grand Rapids, Mich., recently was increased from $500,000 to $1,250,000.

The Universal Iron Foundry and John F. Pitz, Inc., 21 Rose street, New York, have been merged with the Pitz & Webber Iron Foundry.

The capital stock of the Piston Ring Castings Co., Cleveland, recently was increased from $25,000 to $100,000.

Ground has been broken by the St. Louis Malleable Castings Co., St. Louis, for the erection of two plant buildings.

A company has been formed at Grand Rapids, Mich., by R. D. Bourds and G. O. Bouchard, to engage in the manufacture of piston rings.

Erection of an addition to its foundry is contemplated by the Worcester Foundry Co., Worcester, Mass.

The capital stock of the West Steel Casting Co., Cleveland, recently was increased from $100,000 to $500,000.

The capital stock of the Superior Die Casting Co., Cleveland, recently was increased from $25,000 to $50,000.

The Marietta Foundry & Machine Co., Marietta, O., has been incorporated with a capital of $25,000, by R. Ross, O. Morgenstern and C. W. Suder.

The Marion Foundry & Machine Co., Marion, Ind., plans the erection of a warehouse and boiler room.

The Mohawk Piston Ring Co., Cleveland, recently was incorporated with a capital of $50,000, by Harry Decklen, P. Grodner and others.

The Interstate Brass Co., 13 North Dearborn street, Chicago, plans the erection of a storage building.

M. J. Franklin and others recently organized the Calhoun Castings Co., at Battle Creek, Mich.

Work has started on the construction of a foundry building for the Llewellyn Iron Works, Los Angeles.

Erection of a plant addition is contemplated by the Globe Malleable Iron Steel Co., 101 Greenway avene, Schenectady, N. Y.

Capitalized at $20,000 the Quality Foundry & Mfg. Co., Los Angeles, recently was incorporated by Robert J. Schefferly and others.

Having increased its capital from $25,000 to $100,000, the Liberty Foundry Co., Inc., 1831 Centre Line avenue, Detroit, is building a new foundry.

Plans have been prepared for the erection of a foundry, 40 x 80 feet, for the Dayton Standard Scale Co., Dayton, O.

Plans are being prepared for enlarging the general plant and foundry of the Peerless Mfg. Co., Louisville, Ky. The company plans to add stoves to its present output.

The Colonial Brass & Bronze Co., Boston, recently was incorporated with a capital of $125,000, by Thomas F. Brown, Russell C. Harrington and O. W. Harrington.

The Ohio Foundry Co., Vernon, Cal., recently was chartered with a capital of $20,000, by B. G. Hotz, Larne Seibert, 480 North Beadry avenue, Los Angeles, and others.

Capitalized at $20,000, the Economy Sash Weight Co., Los Angeles, recently was incorporated by Edward A. Stephens, A. F. Hannaford, T. C. Burnside, F. G. Mortimer and M. M. Mortimer.

The Holmes Bronze Foundry Co., Cleveland, recently was incorporated with a capital stock of $30,000, by R. F. Holmes, R. E. Fleming, E. H. Peck, J. H. Mills and others.

An increase in the capital stock of the Peninsular Brass Co., Detroit, recently was made, bringing the capitalization of the company to $75,000.

M. J. Prestidge is president of the Dundee Foundry Co., Dundee, Mich., a newly organized company which is operating an aluminum and brass foundry.

The Western Brass Mfg. Co., Los Angeles, recently was chartered with a capital stock of $10,000,

by Nathan Brostoff, David M. Clayman and L. R. Raymond, 115 Sycamore drive, Los Angeles.

Plans have been prepared for the erection of an addition to the plant of the Specialty Foundry & Machine Works, Portland, Oreg. New equipment will be purchased.

The Winner Gas Stove Co., Huntington, W. Va., recently was incorporated with a capital of $50,000, by J. T. Masterson, H. C. Daniels and others to manufacture gas stoves and equipment.

Contracts have been awarded by the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., for the erection of plant additions, including an office building.

The Hinton Foundry & Machine Co., Hinton, W. Va., recently was incorporated with a capital of $5000, by A. D. Daily, V. V. Daly and H. M. Gaff.

Wood and metal patterns will be manufactured by the Universal Pattern & Mfg. Co., Detroit, which was recently incorporated with a capital of $2g,000. Wallace J. Haberman, 343 Dexter boulevard, Detroit, is one of the incorporators.

Capitalized at $100,000, the American Furnace & Foundry Co., Milan, Mich., recently was incorporated to engage in a general foundry business, by F. E. Ross, Ernest L. Watson and Fred E. Fulkerson.

The California Brass Mfg. Co., Los Angeles, recently was incorporated with a capital of $10,000, by Nathan Brostoff, David M. Clayman, 336 West Forty-ninth street, and L. R. Raymond, 115 Sycamore street, Los Angeles.

Special equipment for piston ring work will be required by the Detroit Ring Casting Co., Plymouth, Mich., recently incorporated with a capital of $125,000. It purchased its plant from the National Foundry & Machine Co.

Incorporated in Indiana, the Kokomo Malleable Co., Kokomo, Ind., has a capital stock of $350,000, of which $250,000 is common and $100,000 preferred. Officers are: President, A. G. Seiberling; vice president, Edward Bridges, and secretary and treasurer, Moie Cook.

The Illinois Malleable Iron Co., Chicago, is reported to have completed its plans for the erection of a plant at Louisville, Ky., where it purchased a site of 42 acres some time ago. The plans call for an annealing plant, 113 x 183 feet and a foundry, 147 x 263 feet.

Contracts have been awarded by the Bernert Mfg. Co., 489 Twelfth street, Milwaukee, for the erection of a foundry and machine shop, 130 x 260 feet, which will be equipped to manufacture pneumatic grain handling machinery. George Bernert is general manager.

A large brass foundry is being erected at Waukesha, Wis., by the Waukesha Brass Foundry Co., that city. The building will be 50 x 265 feet, and will be equipped with furnaces equipped with the most modern electric auxiliaries. C. C. Smith is president and general manager of the company.

Construction of a 2-story vault and pattern shop recently was completed for Gray & Dudley Co., Nashville, Tenn. The building is of modern fireproof construction, 40 x 80 feet. In addition to this improvement, the company has under construction a building, 130 x 208 feet, which will be utilized as an addition to the foundry.

Contracts have bene let by the Skagit Steel & Iron Works, Sedro Wooley, Wash., for the erection of a pattern loft, 50 x 120 feet, four stories, and work is now progressing on the construction of an addition to the plant's pattern shop. In addition to these improvements, the company is installing a 2-ton Greene electric furnace.

Recently organized with a capital of $100,000, the LeRoy-Broehm Foundry Co., 932 Jefferson avenue, Detroit, expects to be ready to engage in active business shortly. It has 10,400 square feet of floor space which will be devoted to the production of brass castings. W. W. LeRoy is president, F. R. LeRoy, vice president, and C. G. Broehm, secretary.

The Unit Stove & Furnace Co., Belleville, Ill., soon will be ready to start operation of its plant at Birmingham, Ala., where stoves, ranges, heaters and hot air furnaces will be produced. Edward Leopold is president of the company. The company purchased the old plant of the Birmingham Car Mfg. Co. and has transformed it to a stove foundry.

The plant of the Grand Rapids Foundry Co., Grand Rapids, Mich., which recently was taken over by the Oliver Machinery Co., is being remodeled. The new owner plans to install an electric crane of 10 tons capacity, 38-foot span and 250-foot crane runway. The crane has been purchased but the company is still in the market for the crane runway and accessories. A number of molding machines principally of the heavier type, will be purchased and installed. The location of the cupolas will be changed and two new cupolas, which as yet have not been purchased, will be added. In addition to these improvements, the cleaning room will be modernized and some sand-blast equipment provided.

To meet the plans for enlargement of its production, the Maynard Electric Steel Casting Co., Milwaukee, has decided to increase its capital from $125,000 to $250,000. The company, which was established a number of years ago as the Maynard Steel Casting Co., is gradually changing its equipment to electric furnaces. In the latter part of 1918 it erected a new foundry building, 150 x 250 feet, which is equipped with a 1-ton Rennerfelt furnace and a 3-ton furnace manufactured by W. E. Moore & Co., Pittsburgh, which have a daily production of 25 tons. An addition to the plant, 30 x 200 feet, is now under construction, and an extension to the shipping department, 50 x 75 feet, is planned. Sylvester J. Wabiszewski is president of the company.

New Trade Publications

STEAM REGULATION.—The Hagan Corp., Pittsburgh, has published a folder containing various data pertaining to the loss of fuel energy due to poor boiler regulation.

METALLOGRAPHIC APPARATUS.—Arthur H. Thomas Co., Philadelphia, has published a catalog in which metallurgical microscopes, metallographic cameras, etc., are described and illustrated. Specifications for the various apparatus are given.

INDUSTRIAL TRUCKS.—The Stuebing Truck Co., Cincinnati, has prepared a cardboard folder, in which various data pertaining to the efficient operation of industrial trucks are given. A description of the trucks is given.

SANDBLAST.—A condensed catalog written in Italian has been published by the Pangborn Corp., Hagerstown, Md., for distribution abroad. The various types of sandblast and allied equipment manufactured by the company are described and illustrated.

FURNACE ECONOMIZER.—The Electric Furnace Construction Co., Philadelphia, is circulating a 4-page leaflet in which the use of an electric furnace economizer, which it has designed, is described.

TRUCK PLATFORMS.—Steel platforms for industrial trucks are described and illustrated in a folder prepared by the Ohio Equipment Co., Cleveland. The platforms are manufactured by the Youngstown Pressed Steel Co., Youngstown, O.

METAL HOSE.—The Pennsylvania Flexible Metallic Tubing Co., Philadelphia, is circulating a folder in which metal hose for conveying oils, gasoline, paraffin, etc., is described and illustrated.

FORCE FEED LUBRICATORS.—A booklet has been issued by the Hills-McCanna Co., Chicago, in which force feed lubricators, high pressure gage cocks, boiler compound feeders and boiler test pumps are described and illustrated.

BELTING.—The Graton & Knight Mfg. Co., Worcester, Mass., has published a 38-page booklet in which various data pertaining to leather belting are given. This includes, history and advantages of standardization as regards leather belting. The booklet also contains tables of belting standards for various industries, mechanical rules regarding belting, etc.

GAS GENERATING EQUIPMENT.—The Electrolabs Co., Pittsburgh, has published a booklet in which equipment for generating oxygen and hydrogen gases by decomposing water through passing an electric current, is described and illustrated. The booklet has a number of interesting illustrations, showing large installations as well as a diagramatic layout of a plant.

DECK TABLES.—A bulletin describing and illustrating diagonal deck tables is being circulated by the Deister Concentrator Co., Ft. Wayne, Ind. A number of improvements have been made in these tables, all of which are pointed out in the booklet. The improvements include the introduction of running-in-oil head motions, which are described on pages 7 and 9, and cuts show both the old and new style.

GLUE POTS.—Electric glue pots and their use are described in a folder published by the Oliver Machinery Co., Grand Rapids, Mich. These glue heaters operate on dry heat without the use of water, and are arranged to give three degrees of heat, namely, full, medium and low. The current is controlled by a 3-heat rotary snap switch which indicates the temperatures. Other details are given in the catalog.

BRASS FOUNDRIES.—The S. Obermayer Co., Chicago, has issued a special catalog, a booklet of 112 pages, which is devoted exclusively to the requirements of brass and aluminum foundries. This catalog is complete in every detail and for the convenience of the foundryman, is divided into four sections: Melting, molding room, core room, cleaning and finishing room. The company also has catalog No. 49 for distribution, describing materials for iron, steel and brass foundries.

METALLURGICAL FURNACES.—Annealing and heat-treating furnaces of the under-fired type are described and illustrated in a booklet prepared by the Fuller Engineering Co., Allentown, Pa. The types described are designed with the combustion chambers separated from the heating chambers but connected by suitable ports to permit the hot gases to enter. Dampers control the quantity of heat, and these with a burner adjustment, permit regulation of temperature. The furnaces are described in detail and the illustrations include line drawings.

CENTRIFUGAL PUMPS.—Centrifugal pumps of the the single-stage and multi-stage types for various service, are described and illustrated in a booklet recently issued by the De Laval Steam Turbine Co., Trenton, N. J. The booklet contains complete details, and explains fully the use of pump characteristic curves in adapting pumps to various services, the adaption of centrifugal pumps to different types of drives, and information required by the manufacturer in order to design a pump to suit conditions, etc. Formulas and tables are given for calculating horsepower, efficiencies, the readings of meters, friction in pipe lines, etc.

AERIAL RAILWAY.—The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., has issued a booklet in which electric monorail hoists are described and illustrated. These hoists consist of an electric hoist and cage suspended from trolleys traveling a single I-beam and are operated by electricity. They can be run in either direction at various ranges of speed. In the booklet the plans of two typical installations are shown, with photographs of the machines at work. Each of the several types of hoists manufactured is shown, with detail drawings and in addition specifications of parts are given, while switches, tractage and conductor material are explained and illustrated.